The Energy Conversation

the first 3 years

CNA
ANALYSIS & SOLUTIONS

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
JUL 2009		**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The Energy Conversation. the first 3 years	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **CNA Analysis & Solutions,4825 Mark Center Drive,Alexandria,VA,22311**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**68**	

The Energy Conversation

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Published by

CNA
ANALYSIS & SOLUTIONS

This book is made possible thanks to the following:
DOD Office of Force Transformation
DOD Director of Defense Research and Engineering
Navy Office of Naval Research

CNA
Robert J. Murray, CNA President and CEO
Mitzi Wertheim, Director of *The Energy Conversation*

Printed in the United States of America on recycled paper.

Without courage, all other virtues are worthless.

— Winston Churchill

Energy and persistence conquer all things.
— Benjamin Franklin

WHY ENERGY?

Energy is *the* common factor. If you stop to consider, every aspect of modern society is shaped by energy — from transportation to food to national security to environmental disaster. So, as we take on the massive problems we are faced with today, it is incumbent upon us to factor in this critical element. But, how do we do this? It begins, we believe, with conversation.

Fortunately, the dialogue has already begun. ***The Energy Conversation***, which met formally for the first time on March 29, 2006, brings together a diverse group of senior leaders, scientists, researchers, and academics from government and beyond. It provides a forum — beyond the confines of a single institution or specific field of study — in which to debate the world's problems. And, because participants come from such varied backgrounds, everyone is able to consider issues not just from one point of view but from many. Over the course of 31 conversations, we've explored biofuels and windmills; we've looked at IBM's policies and the economic impacts of climate change; we've discussed national security and nuclear power; and we've considered our oil addiction and Germany's commitment to renewable energy.

Our discussions have been lively. Over the past 3 years, we have come to realize that some of our proposed ideas might not work; though many of them will. We understand that science is not static; it is a process, an evolution fed by spirited conversation and dissenting views.

However, regardless of the topic or the viewpoint, we always come back to the fact that energy — whether framed economically, politically, or environmentally — is the single most important issue of our time. For it lies at the very core of our modern world. From the Pentagon to Wal-Mart, ***The Energy Conversation*** recognizes that all people not only have a stake in the outcome but also a responsibility to enter into the conversation.

In the next pages, we invite *you* to participate.

As our case is new, we must think and act anew.

— Abraham Lincoln

OUR STORY

In October of 2004, Marv Langston, who had been the first Chief Information Officer (CIO) of the Navy, heard Jim Woolsey speak at a conference. Woolsey had been the Under Secretary of the Navy, and then went on to become the Director of the CIA.

"If you were elected President," Woolsey was asked, "What would you do?"

"I would eliminate our dependence on Middle East oil," he responded.

Langston, then a senior strategic planner for Science Applications International Corporation (SAIC), in California, called Mitzi Wertheim and flew out to Washington, DC to meet her for lunch. Wertheim had been Woolsey's Deputy Under Secretary of the Navy. She is also the ultimate outside-the-box thinker, having worked not only at the Peace Corps, but also at the Pentagon and for IBM as the marketing manager for President Reagan's Star Wars program.

"We need to do something about this energy issue," Langston said, after telling Wertheim about Woolsey's response at the conference.

"Well, sure, Marv," she smiled, "But I'm a social anthropologist and I don't know anything about energy."

Langston wasn't deterred. He asked her to bring some people together who might be interested in learning about and working on the energy issue. She agreed, but only if the objective was to address an energy-illiterate nation and develop a road map to chart a course for the next century.

It was a chilly evening in January 2005 when a few people gathered at Wertheim's house in Cleveland Park. The meeting would become ground zero for those working to make change happen in the energy arena sooner rather than later. A sense of urgency permeated the meeting — catastrophic climate change issues and war. Indeed, the biggest cost to the military was soldiers getting killed or maimed by Improvised Explosive Devices (IEDs) while transporting liquid fuels.[1]

The group's members were primarily engineers at first, but as the effort grew, the group became increasingly inter-disciplinary and inter-generational. Eventually the group consisted of high-level Pentagon officials and advisors, Service members, intergovernmental personnel, industry leaders, congressional staffers, leadership consultants, a PBS producer, a Pulitzer prize winner, and a Hollywood screenwriter — each one passionate about energy.

[1]The February 2008 Report of the Defense Science Board Task Force on DOD Energy Strategy "More Fight - Less Fuel" points to a number of unacceptable risks in the field and on bases due to energy insecurity. See the full report at www.acq.osd.mil/dsb/reports/2008-02-ESTF.pdf

So began a collective exploration of everything there was to know about energy — context, connections, cause, choices, consequences, and systems dynamics. A 24-hour energy group email conversation gained momentum as we began sharing and debating information, articles, legislation, policy, and all flavor of ideas. A monthly series of evening discussions followed. This energy discussion group is now referred to as **The Energy Consensus**.

By May 2005, **The Energy Consensus** was growing. More people, most of them military, were showing up at the meetings, eager to talk about energy and possible solutions to the growing threats. There was no money to support this effort. We in the **The Energy Consensus** were all volunteers, understanding only that the topic was vitally important and that we shared, to varying degrees, ignorance about all its facets. We also understood that everyone in the conversation had to participate as equals no matter what their institutional status. If we were to have any effect on changing the behavior of individuals and institutions, we had to find a way for people to break out of their professional silos and listen to each other, share ideas and strategies, learn from one another, and collaborate on creating a knowledge base that will — in the long run — change the behaviors of institutions.

We believe conversation is essential for change to happen. In fact, former Secretary of Defense Donald Rumsfeld wrote a snowflake memo after having a conversation with an Energy Consensus member in mid-December 2005. In that memo, he asked the Department of Defense (DOD) what it was doing about advanced sustainable energy technologies; it provided the impetus for the creation of two new task forces: Defense Science Board Task Force on DOD Energy Strategy and the DOD Energy Security Task Force. But, more importantly, it put energy on the table at the DOD.

A week after the snowflake memo, on December 21, 2005, an email went out to **The Energy Consensus**. It read: "If you had 15 minutes with the Secretary of Defense, what would you want to tell him about energy?"

Within 48 hours there were enough replies to fill 15 single-spaced pages. Linton Wells, then the Principal Deputy Assistant Secretary of Defense (Networks and Information Integration), and a member of the group, sent the paper around DOD. The conversation began to grow, attracting participants at increasingly higher levels of governance.

A month later, on January 20, 2006, President Bush gave his State of the Union speech, in which he stated that "America is addicted to oil." Press reports indicated a direct link from The Energy Consensus conversation to the State of the Union reference.With those five words the floodgates were opened, and for those working to change the way the world uses energy, it was a whole new game. It was finally okay to talk about energy policies — the pros and cons.

Early in 2006, the DOD Office of Force Transformation became our sponsor for a monthly evening seminar series called: "Energy: A Conversation About Our National Addiction".

Within a year, other agencies that had a major role in the government energy story joined in. The Departments of State, Treasury, Interior, Agriculture, Commerce, Health and Human Services, Transportation, Energy, Education, Veterans Affairs, and Homeland Security; the Environmental Protection Agency; the Office of Science, Technology and Policy; the Council on Environmental Quality; the Office of the Secretary of Defense; the Army; the Navy; the Air Force; the Coast Guard; the Director of National Intelligence; the Central Intelligence Agency; the Federal Energy Regulatory Commission; the General Services Administration; the National Aeronautics and Space Administration; the National Science Foundation; the National Academy of Sciences; and CNA became co-sponsors of ***The Energy Conversation*** and collaborators in the effort. Indeed, it was CNA that served as an incubator for the Conversation's strategic direction, vision and new ideas.

The Conversation's membership is now in the thousands — including individuals in high-level positions who volunteer their time and serve as a link between their agency and our Conversation.

DOD holds a unique position. As the single largest buyer of energy in the world and the nation's largest energy consumer, at an estimated ~1.5% of the nation's total energy consumption, the DOD leads the nation in terms of using sustainable technologies. Because of this, it can see a need, create a demand, drive business, and lower cost. From Civil War railroads to microchips, rapid advancements in technology have historically been moved by the military.

Energy is a dynamic issue that a linear approach cannot resolve. To save energy, you have to use it efficiently — if you need less, you use less, and you save more money. This also applies to DOD and its activities.[2]

[2]One tool DOD uses for energy cost consideration is called the Fully Burdened Cost of Fuel (FBCF). The FBCF is the commodity price of fuel plus the total life-cycle cost of all people and assets required to move and protect fuel from the point of sale to the end user — primarily troops in the field who have to deliver the fuel to operational forces, and the combat forces who have to protect the fuel convoys. By including all these costs incurred in order to deliver energy (direct and indirect) DOD can more accurately determine how much it's worth to invest in technologies and performance characteristics in order to reduce energy demand. It applies activity-based costing principles to understand the full cost savings that would accrue from reducing the amount of energy its systems require. As energy demand is reduced, the logistics footprint is also reduced. But there is more at stake than money when logistics convoys have to operate in contested areas. Lives and the ability to successfully perform the military mission are at risk too. The operational risk associated with high-energy demand is captured by another DOD planning factor called the Key Performance Parameter, or KPP. It acts to constrain the amount of energy a system will be allowed to demand in combat. The longer the supply chain and the greater the enemy threat along the convoy route, the more important this factor becomes. With the knowledge that energy sustainability is the key to national stability and security, DOD understands the need to create energy literacy through initiatives such as the energy KPP and FBCF.

The Energy Conversation guest speakers, from industry, think tanks, government, and military, attract an array of people from different sectors who are equally dependent on energy and who are also critical actors in the solution. The core team that supports ***The Energy Conversation*** serves as a sustainability think tank, creating materials and programs that foster energy literacy and discussion on all aspects of sustainability. Besides a number of concrete projects, all those involved in ***The Energy Conversation*** are continually expanding the Conversation to their own agencies and networks, creating a ripple effect. We believe that to be effective, the Conversation must continually evolve, grow, and change to take advantage of whatever situation exists at any given point in time. The only way to become more relevant is to involve institutions in the network and in the collaboration itself. This book is an extension of that idea. We hope that through its publication, the Conversation will continue to grow. It is our aim that ***The Energy Conversation***'s interchange of ideas will help to generate policy and program proposals among its Federal Partners and that the interactions among participants will facilitate government-wide coordination in implementing these policies and proposals.

THE FIRST THREE YEARS: MONTHLY CONVERSATIONS

1 *ENERGY, SECURITY & THE LONG WAR OF THE 21ST CENTURY*

R. James Woolsey *(Former Director of Central Intelligence, Venture Partner, VantagePoint Venture Partners)*

- DOD is concerned about the future of energy in military installations, for transportation, and as a criterion in weapon system acquisitions
- There are enormous implications for management of processes, structures, and the entire scope of operations
- There is a need for a collaborative environment for members of DOD and other institutions to come together and share ideas, technologies, and strategies for mitigating the coming energy crisis
- The long war of this century is different than the Cold War, in which the enemy was less ideologically committed and had much less economic leverage
- The United States is vulnerable to attacks on its energy infrastructure
  - The power grid
  - Oil infrastructure, especially in the Middle East
- Our dependence on oil perpetuates our vulnerabilities
  - Oil helps foster autocratic regimes and, directly and indirectly, funds terror
- The terrorism of today presents itself in non-traditional ways, very different and potentially far more destructive than most 20th-century terrorism
- The world's dependence on, largely, autocracies for oil, has immediate consequences. Iran's oil, for example, makes it less likely that most states will use effective sanctions against it to stop its nuclear program
- When oil is in the range of $70-$140/barrel, we borrow $400-800 million per day just to import it. Even at lower prices, petroleum's monopoly of transportation heavily weakens the dollar and deprives us of energy-related jobs
- Areas in which transformation could occur:
  - Hybrids could evolve into plug-in hybrids; if these are constructed from carbon-composite materials to reduce vehicle weight while maintaining safety, we can achieve as much as 500 miles per gallon
  - An accompanying shift from oil products to biofuels produced from waste and cellulosic feedstocks could improve plug-in hybrid mileage to 1000 mpg (of gasoline) or better[2]
  - All this leads in one grand strategic direction: We must destroy oil's monopoly over transportation and, with it, OPEC's dominance

[2]Ethanol technology has been highly debated at ***The Energy Conversation***. There are generally three feedstocks for it today: corn, sugar cane, and (in early stages) cellulosic, such as switch grass, waste, and other plants. All three, as well as biodiesel, reduce our reliance on petroleum but cellulosic ethanol (or subsequently biobutanol) shows other efficiencies and is more compatible with distributed production near where fuels are needed.

2 *AVERTING A LIQUID FUEL CRISIS FROM PEAK OIL*

Robert Hirsch *(Energy Advisor);* **Congressman Roscoe Bartlett** *(R-MD)*

- Oil is the life-blood of modern civilization. Virtually everything that we consume comes to us by carriers that cannot operate without liquid fuels. World commerce is critically dependent on abundant and reasonably priced oil
- World oil production is at or near maximum for the first time ever
- While the current worldwide economic crisis has had a modest impact on world oil consumption, the impact has not been dramatic
- When oil production decline begins, oil shortages will develop and increase each year until mitigation takes hold 10-20 years later. Oil prices will escalate dramatically and economic damage will increase
- Production from every oil field goes through phases of growth, maximum, and decline; these phases are fundamental and strongly associated with the fact that oil is a finite, depleting resource
- Oil production from countries goes through the same phases. Today, 55 of the world's 65 largest oil-producing countries are past their production peaks and in decline
- As a result, after more than a century of world oil production generally rising to feed economic expansion, production has entered an unprecedented plateau period, as seen in *Figure 1* with only a 4% fluctuation band since 2004

Figure 1. Total world liquid fuels production

- Many prominent organizations and individuals believe that world oil production has or will soon be inadequate. They include:

- IEA, Chevron, Shell Oil, Total Oil, Statoil, Hess Oil, Toyota, Volvo Trucks, the Corp of Engineers, CIBC (Canada), EWG (Germany), Jim Schlesinger, Boone Pickens, Matthew Simmons, and many retired oil company geologists
- The few organizations that believe that there is no near-term oil supply problem include OPEC, Exxon, BP, and EIA

❖ Mitigation of declining world oil production will be possible but it will be extremely expensive and represent a massive undertaking

❖ We should invest in more efficient light-duty vehicles; enhanced oil recovery, heavy oil, and oil sands; and coal-to-liquids. We also need to conserve and ration. And, though rationing could happen quickly, it would be extremely complex to administer and also very painful for fuel users

❖ Mitigation options that save or produce liquid fuels will be a problem for decades, because of the long lifetimes of the world's huge fleets of liquid fuel-consuming cars, trucks, airplanes, ships, and other vehicles

❖ Electric power options produce electricity, which will be of value in mitigating oil shortages until existing fleets are replaced to run on electric power. Such energy switching is possible in some cases but not in others

❖ An analysis for the Department of Energy (DOE) considered the potential impact of a worldwide crash program to combat declining liquid fuels supply

❖ The conclusions were:

- At likely oil production decline rates, the problem runs away from our best mitigation efforts for well over a decade
- The related economic impacts will be severe and increase year after year until mitigations take hold
- The impacts on world Gross Domestic Product (GDP) are likely to be roughly proportional to the annual decline rate of oil supply, which means deepening recession for more than a decade. *Figure 2* shows how this might play out

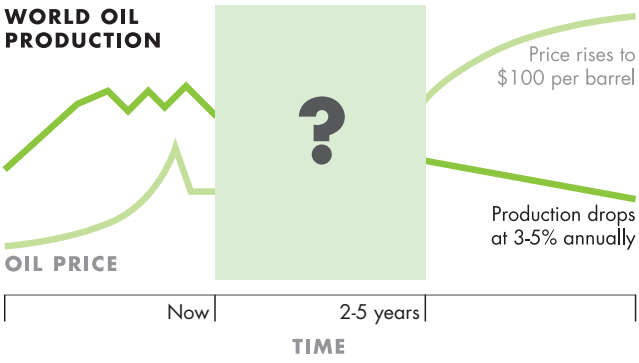


Figure 2. How world oil production and oil prices might evolve over time

- The important take-away points are as follows:
  - The decline of world oil production is unavoidable, and it could begin in a matter of a few years
  - The problem will be one of liquid fuels, not energy
  - Many mitigation options are available and will be needed
- Deployment of technologies will be critical, massive, time-consuming, and extremely expensive
- Growing economic hardship will occur worldwide for more than a decade, because there will be no quick fixes

❖ While there will be great pain for many, there will also be opportunities for those who seize them

❖ In conclusion, Congressman Roscoe Bartlett stated:
- With the US being one person in twenty-two of the world's population, with 2% of the known oil reserves, it actually uses 25% of the world's entire supply of oil and imports two-thirds of its oil

3 *THE HYDROGEN ECONOMY*

Jeremy Rifkin *(Foundation on Economic Trends)*

❖ On a hydrogen economy as it pertains to Europe:
- Europe is increasingly dependent on oil and natural gas from Russia
- Russian natural gas makes up 25% and oil 30% of European supply

❖ How do we prepare for a transition to a post-oil era?
- Hydrogen addresses this safely, and efficiently, with the least devastation to the economy
- Hydrogen is the lightest and most abundant resource in the universe

❖ The only by-products of hydrogen are pure H_20 (water) and heat

❖ In every era of new energy, significant advancements occur in economic development, productivity, and in job creation

❖ Advancements in energy technology often accompany advancements in communications:
- Cuneiform writing and agricultural innovation in Sumeria
- Coal and the printing press
- Oil and the telegraph
- Hydrogen/distributed generation and the Internet

❖ Hydrogen is already entering the commercial market, but a commitment to innovation and a significant investment in infrastructure is needed

❖ Production is complicated and problematic in terms of input ratio

❖ Rifkin suggests using renewable sources such as solar, wind, and geothermal to produce electricity for further use in a process. This is known as electrolysis, or the splitting of the H_20 molecule into its respective elements, enabling zero carbon (CO_2) emissions

❖ Downsides to a hydrogen-centric economy?
- Hydro technology is based on one assumption: the availability of water

- Over-reliance on water as a central input in an energy infrastructure is not a sustainable solution

❖ Energy demand is charted to grow by almost 50% in the next 20 years. We do not yet fully understand what effects climate change will have on arctic permafrost, glaciers, and the world's water supply

4 *TWILIGHT IN THE DESERT*

Matthew Simmons *(Author, Peak Oil Expert)*

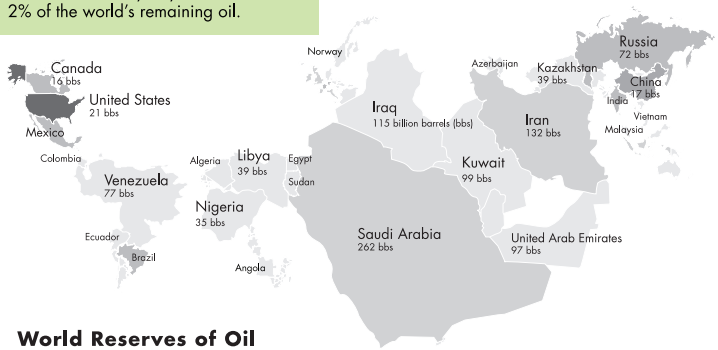
❖ Energy is directly related to our national defense systems, and the ability to ensure security. This is increasingly challenged by Middle East oil in the twilight era, or an imminent peak

❖ Long-term supply and demand of oil is demand driven. When supply becomes a plug factor, demand outpaces supply and causes continuous increases in price

❖ Water injection has kept the reservoir pressures high. Oil field high technology has concealed rising water cuts

WHO HAS THE OIL?

The US consumes more than 20 million barrels of oil every day but has less than 2% of the world's remaining oil.



World Reserves of Oil

	Billions of Barrels	% of World Reserves
Saudi Arabia	262.73	22.3%
Iran	132.46	11.2%
Iraq	115.00	9.7%
Kuwait	99.00	8.4%
United Arab Emirates	97.80	8.3%
Venezuela	77.22	6.5%
Russia	72.27	6.1%
Kazakhstan	39.62	3.4%
Libya	39.12	3.3%
Nigeria	35.25	3.0%
United States	21.37	1.8%
China	17.07	1.4%
Canada	16.80	1.4%
Qatar	15.20	1.3%

The Middle East controls more than 60% of the world's remaining oil.

Who uses the oil?
(thousands of barrels per day)

- 6000+
- 3000–5999
- 2000–2999
- 1000–1999
- 0-999

Each country's size is proportional to the amount of oil it contains (oil reserves);
Source: BP Statistical Review Year-End 2004 and Energy Information Administration

- Saudi Arabian oil fields are increasingly mature
  - Water injection has kept the reservoir pressures high
  - Oil field high technology has concealed rising water cuts
- Rock and permeability are insufficient for sustainability in remaining oil fields
- Drawing on Shell Oil CEO Jeroen van der Veer's assertions that the world's role in the future of oil can take either a scramble or a blueprint mode in years to come, Simmons gave gave these assessments:
  - 40% chance of remaining at an undulating plateau. This would entail marked increased discoveries worldwide
  - On the probability of per annual decrease in supply, he finds a 35% chance of a 5% decline and a 25% chance of a 10% decline
  - Additionally, Simmons cited rust (the age of oil/gas delivery infrastructure), a decreasing spare capacity, and an increasingly invisible inventory as other related factors in the onset of a peak era
  - Overall, Simmons points to an imminent future decline in the feasibility of reliance on Middle East oil

5 *BIOFUELS AND BIOMASS*

Dr. Michael Pacheco *(National Renewable Energy Laboratory);*
Suzanne Hunt *(WorldWatch Institute)*

- Liquid biofuels currently supply around 1-2% of global transport fuels while using less than 1% of world agricultural land
- Ethanol use has grown by ~12% annually over the past 7 years, more than doubling its production
- The relative share of biofuels could be increased if a range of demand-side efficiency measures effectively reduced total fuel demand growth in the transport sector
- In addition to biofuel production, crops used for energy often also provide co-products such as animal fodder, fertilizers, and electricity
- In the US today, about half the gasoline sold at the pump is already 10% ethanol
- Biodiesel can be used in diesel engines in either its pure form or as a blend with conventional diesel fuel
- Advanced biofuels and other biofuels derived from switchgrass, garbage, and algae are now under development in the US, Europe, China, and elsewhere
- Biofuels should eventually see a move from sugar and corn to more efficient cellulosic forms. Estimated goals for the US:
  - 60 billion gallons per year of biofuel by 2030 if costs reduce to $1.10 per gallon. This equates to a little over 1.42 billion barrels, or 152 days worth of oil. If ethanol is .67 the energy content of regular unleaded gasoline, this means one actually needs 1.88 billion barrels to obtain the same output

of energy at current day demand. Likewise, if biodiesel is .86, the energy content of unleaded gasoline, one would need 1.61 billion barrels to obtain the same level of output
- Ethanol production has quadrupled in the US and in Brazil in recent years. Brazil uses 50% of its cane to produce ethanol
- Sugar cane ethanol prospects and challenges:
  - It takes a lot of coal and gas to produce ethanol
  - Sugar cellulosic, however, can yield 50% more efficiency than corn

❖ Factors that influence cellulosic potential include:
- Developments in improved yield
- Human population reaching 9 billion, which would greatly affect land availability
- The utilization of waste
- Energy conservation

❖ The uncertainties of sugar cane ethanol include:
- Competing uses
- Climate change
- Commerce transit
- Infrastructure for liquids
- Technological hurdles
- Public acceptance (market driven)
- Trade — Agricultural vs. fuel
- High tariffs in the US, Australia and Canada
- Cane ethanol fuel is more labor intensive than oil
- Tropical climate is the best for supplying
- Social/political conflict over land and water could be problematic

❖ The food vs. fuel debate:
- Biofuels raise food prices, especially for the poor

❖ Summary of biofuels recommendations
- Integrate and better coordinate policy frameworks
- Assess and monitor benefits and impacts of biofuels trade, use, and production
- Address negative indirect effects of biofuels trade, use, and production
- Reward positive impacts and investments, including through carbon management
- Use informed dialogues to build consensus for new projects
- Increase investment in research, development, and demonstration
- Build capacity to enable producers to manage carbon and water
- Make sure that trade policies and climate change policies work together

6 *NUCLEAR ENERGY: STATUS AND OUTLOOK*

Admiral Frank L. (Skip) Bowman *(Retired; Former Director of Nuclear Energy Institute)*

- Current status of nuclear power and its prospects and challenges for the future:
  - There are often three "yes-buts" from the public with nuclear power:
    - Safety and security (indirectly related to proliferation)
    - Financing new reactors
    - Used-fuel management or waste
- Nuclear power comprises ~20% of US electricity consumption:
  - ~100 commercial reactors and ~100 naval reactors
- To put this in perspective, electric power plants in the US are run using the following:
  - ~50% coal
  - ~20% nuclear
  - ~20% gas
  - 7% hydro/renewable
  - 3% oil
- Nuclear plants produce 73% of all carbon-free electricity generation in the US
- A small percentage of plants are powered using imported energy
- Current US nuclear power reactors are both pressurized water and boiling water reactors
- The benefits of nuclear energy:
  - The price of electricity is cheap and stable with respect to market volatility, unlike non-renewable energies
  - No emissions in the production of nuclear energy; nuclear energy avoids the CO^2 emissions of an equal amount of output of 130 million cars
  - Nuclear plants are safe; scram incidents are rare[3]
  - Nuclear plant capacity factor has greatly increased in recent years (90% from 2000-2006)
  - Market share has grown 25% without increasing the number of plants through greater efficiency and uprates at existing reactors
- Concerns regarding nuclear energy:
  - Large amount of water needed to cool the reactor, although most of it is returned to the source
  - The issue of nuclear waste:
    - Technical solutions now exist but so do political hurdles
    - The federal government was to begin managing fuel rods from commercial reactors in 1998 but has not yet done so

[3]For a full description of scram incidents, see "Reportable Event Report on Maanshan Nuclear Power Station Unit 2 Reactor Scram Incident, (RER-94-32-002)," Atomic Energy Council, www.aec.gov.tw/english/nuclear/article.php?n=rer9432002

7 *ADVANCES IN SYSTEMS APPLICATION OF SOLAR POWER FOR CRITICAL FUNCTIONS*

Scott Sklar *(Distributed Renewable Energy Expert);*
Robert Birkmire *(Institute for Energy Conversion, University of Delaware)*

- A primary concern for power generation is that normal functions of society continue when and if the grid goes down:
  - Independence from the grid can free up many existing inefficiency problems
  - Renewable energy technologies, such as photovoltaics (PV), solar thermal, wind, smart battery banks, and others, enable integration independent of the grid
  - The blending of distribution generation is central to implementing renewable energy technologies
- Environment, population, and security are key areas in which to address the grid
  - Environmental side: fossil fuels are either causing or accelerating climate change
  - Population: currently 6.5 billion, a third do not have electricity
  - Security: grid is vulnerable to terrorism; threatening nature of this will be exacerbated as global population is projected to reach 9 billion by 2050
    - Distributed generation powers infrastructure such as lighting, monitoring surveillance, pipeline pumps (water, fuel, sewage, etc.)
- Photovoltaics (PV) is the field of technology and research related to the application of solar by converting sunlight directly into electricity
  - PV production has increased by 38% each year since 2002, making it the world's fastest-growing energy technology
  - PV energy has the potential to provide 15-20% of the world's electricity
  - PV generator sets are potentially more reliable than the diesel ones used
  - Other renewable forms of energy will be critically necessary as well
- Solar thermal energy is a technology for harnessing solar energy for thermal energy (heat) — otherwise defined as low-, medium-, or high-temperature collectors
  - Medium-temperature collectors are usually flat plates used for creating hot water for residential and commercial use
  - High-temperature collectors concentrate sunlight using mirrors or lenses and are generally used for electric power production
- The electric grid is subject to transmission and distribution line congestion
  - Primarily due to immense increase in midday electricity due to air-conditioning loads
  - By dispersing electric power closer to the point-of-use, it is possible to have a more agile and reliable electric grid
  - PV and solar thermal have the proclivity to provide midday power
    - lowering power line congestion
    - can be distributed along both transmission line, distribution lines, at substations, and even on the customer side of the meter
- Breakthrough advancements in solar technology: solar thin film
  - The technology is based on copper indium gallium selenide (CIGS), arranged on a flexible backing as well as light-sensitive nanotechnology dyes

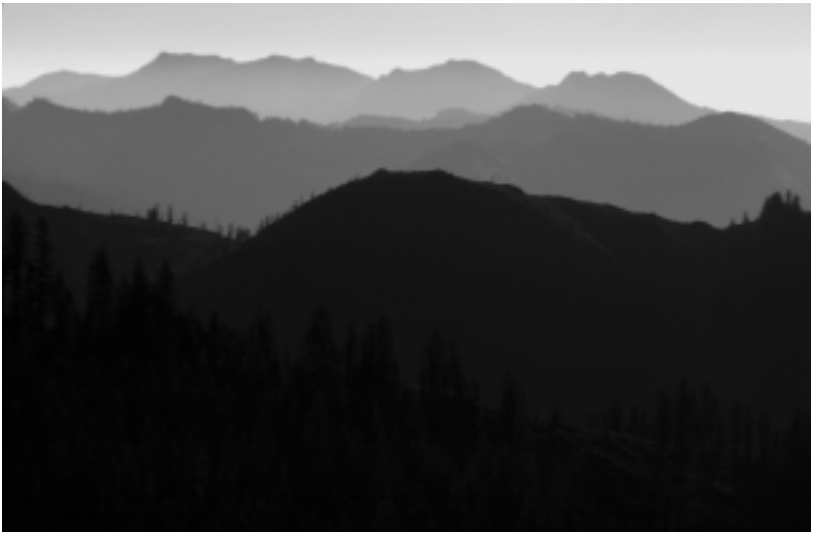


photo courtesy of **Fish and Wildlife Service**

- Suitable for not only the tops, but also the sides of buildings; tinted windows; cell phones; notebook computers; cars; tents; clothing
- Thin film solar panels are printed onto the rolled backing
- Eliminating many of the highly energy and chemical intensive processes typical in conventional PV manufacture

❖ Military use of PV on the battlefield is a significant advantage:
- Thin film solar cloth enables soldiers to cut their backpack loads by one half, enabling much greater mobility and endurance. Other uses include charging field phones, solar cookers, tents, etc.
- Additionally, PV prevents the enemy from registering heat signals, and noise or seeing a plume of smoke emitted, depending on use.

8 *A PARADIGM SHIFT — FROM WASTE TO FUEL*

Brian S. Appel *(CEO, Changing World Technology)*

❖ Waste-to-fuel (producing energy out of everyday items) is considered a renewable diesel
- Proportionally distributed where people are located
- Proportionate to the amount of energy consumed in these areas

❖ Thermal conversion process, or thermal depolymerization:
- Waste fuel is produced using water, temperature, and pressure
- Takes waste (e.g. fats, bones, feathers, sludges, tires, even refrigerators) and grinds it up
- Remaining material is pressurized and heated in pumps; separates organics from inorganics (calcium, phosphates, and other solids are separated from proteins, carbohydrates, and fat)

- Advantages of biodiesel waste-to-fuel include:
  - Biodiesel is a direct substitute for fossil fuel-based energy
  - Reduces the need for fossil fuel drilling
  - Future fuel costs could be controlled; hedge role in relation to oil
  - Interruptions in fuel supply less likely in the event of a war
  - If we could use waste, we would less likely go to war over oil
  - Agricultural waste — 6 billion tons per year
  - People massed around where waste exists and energy is needed; transportation costs can be dramatically cut
  - Industrial waste makes up 768 million tons per year
- Animal waste (the carcasses of chickens, cows, and pigs, which would otherwise be used as feed for other animals) totaling 23 million tons per year, could produce 30 million barrels of fuel per day

9 *THE OIL ENDGAME*

G. Amory Lovins *(Director, Rocky Mountain Institute, Defense Science Board)*

- Amory Lovins's book, *Winning the Oil Endgame* (www.move.rmi.org), outlines an efficiency-based vision, using DOD as a model
- The discussion of the revolution in military affairs over the 1990s resulted in DOD's improving strategic vectors of speed, stealth, precision, and networking
- DOD should excel at two new strategic vectors, endurance and resilience
- Our issues with oil today resemble the issues we had with salt over a century ago. Until that time, salt was used to preserve food. However, with the advent of refrigeration, salt consumption plummeted. As a result, its value decreased and conflict over the mineral fell dramatically. Moral of the story: if we stop consuming oil, it will diminish in value and there will be no need to fight over it
- A systemic shock to oil:
  - We can render oil largely irrelevant by 2030, and far less important by 2020
- Lovins outlines the possibilities of efficiency in the context of endurance and resilience
  - Introduction of ultralight, ultralow-drag, and advanced propulsion into vehicle production. Efficiency averaged across all military platforms can triple over several decades, with uncompromised and generally improved combat capability
- Integrate the use of carbon fiber composites into vehicle design. Carbon fiber composite is much lighter than steel; several times stronger
- Reduce the weight and, subsequently, the energy required to move the vehicle (Most of the fuel that goes into acceleration is based on vehicular weight)
- This revolution could start in DOD and spread across industry
- Advanced composites offer strategic advantages in manufacturing but must also compete with valid metal solutions

10 *WAL-MART CUTS ENERGY 30% — WHAT CAN WE LEARN FROM THEM?*

Charles Zimmerman *(VP, Prototype & New Format Development, Wal-Mart)*

- Wal-Mart is committed to building sustainable facilities
- Wal-Mart will make a 20% energy/greenhouse gas reduction in existing stores within the next 7 years
- The company has approximately 6,500 operations worldwide (3,900 in the US and 2,600 internationally)
- The company looked at ways it was using energy and introduced some of the following technological changes:
  - Daylight harvesting
  - Cool roofing; heat reclaim
  - High efficiency heating, ventilation, and air conditioning (HVAC)
  - Centralized Enterprise Management Server (EMS)/monitoring
  - Active de-humidification
  - Exterior Light Emitting Diode (LED) signage
- Future Wal-Mart initiatives include the following:
  - Interior LED lighting
  - Additional speed fans/motors in HVAC systems
  - Variable speed fans/motors and floating pressures (refrigeration)
  - Emerging HVAC technologies
  - Emerging refrigeration technologies (CO^2 secondary loop)
  - Rainwater harvesting
  - Domestic water conservation
  - Construction debris recycling
  - Increase in recycled products
  - Teaching competitors about Wal-Mart's success in energy

11 *THE ECONOMIC IMPACT OF CLIMATE CHANGE — THE STERN REVIEW REPORT*

Justin Mundy *(Senior Advisor on Climate Change to the UK Foreign Ministry)*

- The Stern review, on the economics of climate change, is a 700-page report that was released on October 30, 2006, by economist Lord Stern of Brentford for the British government. In it he discusses the effect of climate change and global warming on the world economy. The study concludes — among many other findings — that the benefits of strong and early action far outweigh the economic costs of inaction[4]
- There is overwhelming evidence that climate change presents very serious global risks and demands an urgent global response
  - Economically, it is the greatest, wide-ranging market failure ever seen

[4] Stern Review on the economics of climate change. 2006. "Stern Review final report." Her Majesty's Treasury. www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm

- Benefits of strong, early action outweigh the costs
  - Increasing risks of serious, irreversible impacts associated with business-as-usual
  - 31 of the 35 mega-cities in the world are vulnerable to the rise in sea levels
- Investment in energy in the coming decades will reduce the risks of severe and permanent consequences in the future
- Can the world be sustained at a CO^2 atmospheric level of 550 parts per million (ppm)?
  - Currently the planet is at 430 ppm
  - At 450 ppm, average global temperature will increase by 2 degrees Celsius
  - At 550 ppm it would increase 3 degrees Celsius
- Effects of long-term business-as-usual:
  - Massive crop failures
  - Food depletion
  - Social and security collapse
- Significantly different security challenges in the next 100 years than ever seen before
  - Growing and populous regions (China, India, and Sub-Suharan) scramble for remaining resources
  - US and European militaries will be called upon to deploy to certain crises that arise
  - There is a need for additional personnel to address the issues related to climate change
  - National identity will dwindle to potentially creating violent extremism
  - Costs to combat this environment would reach a minimum of $18 trillion
  - The Stern Review finds that solutions to mitigation do exist presently
  - Solving climate change cannot be dealt with on a national level — global cooperation is needed
- Some additional issues to consider:
  - Policy should seek the diversification of energy
  - Increase security around infrastructure

12 *REDUCE COSTS, SAVE ENERGY — BUILDING GREEN: LEEDING THE WAY*

Teresa Pohlman *(master planner, Pentagon Greening);*
Bob Fox *(Cook & Fox Architects)*

- On US energy consumption and buildings:
  - The US currently represents about 4.5% of the world's population
  - Consumes 24% of the world's resources
  - Buildings alone produce 43% of the CO^2 in the US
  - We need to take carbon out of the equation — starting at the point of design
- Questions to ask when building the LEED (Leadership in Energy and Environmental Design) way:
  - How are you contributing to the bottom line?
  - What's your payback?

- How will you add value to the project?
- How are you contributing to the mission?

❖ Pohlman on the Pentagon Greening:
- Bringing Pentagon facilities to LEED certification was a 6-year project based at the Pentagon Renovation Office
- The Pentagon was built in 18 months, under extreme wartime pressure
- Renovation was allotted 15 years; like making a black and white TV into a color TV without turning the set off
- The mission in renovation: save energy; realize energy efficiency and environmental sustainability on a budget

❖ The Pentagon covers 24 acres, 6.5 million square feet, with approximately 17.5 miles of corridors and 25,000 personnel

❖ Budgets often lead to cutting items/materials deemed not essential to the design of the project. Instead it's more important to look for return on investment

❖ Fox on considering the design of Bank of America Tower, One Bryant Park, New York City:
- The first thing is to look at what is free?
  - Sun/daylight
  - Rain/snow
  - Biological processes (cafeteria food waste into an anaerobic digester for power generation)
  - Thermal energy (constant temperature of the earth)

❖ Bank of America Tower, One Bryant Park, New York City, stand outs:
- On-site power generation (4.6 mega watt cogeneration plant)
- Health and productivity is prioritized with 95% air filtration, under-floor ventilation system, natural daylighting, use of low-VOC (Volatile Organic Compound) materials
- Graywater system recycles storm water and wastewater; total savings of 7.7 million gallons per year
- Thermal storage system produces ice at night, melting during day to shave daytime peak energy loads
- High-performance curtain wall of low-iron glass with custom fit pattern that balances energy use with daylight and views
- All cement is made of 45% blast furnace slag, an industrial by-product; 56,000 fewer tons of CO^2 were released by using this by-product when compared with the production of new cement
- Nearly zero storm water contribution to New York City sewer systems

❖ Recommendations:
- Unification of process as a fundamental principle:
  - Promote innovation and excellence — value-added components
  - Address acquisition strategy — getting sustainability in the very beginning

13 *OUR DEPENDENCE ON WATER — WATER'S DEPENDENCE ON ENERGY*

Mark Shannon *(Director of the National Science Foundation Center of Advanced Materials for Purification of Water with Systems, University of Illinois)*

- Our dependence on water and how we access water depends on energy:
  - Water transport, treatment, and supply accounts for one of the largest users of energy in the US
- We need to develop more energy-efficient ways to purify water
  - Creating fresh water from inland saline lakes and aquifers and contaminated water sources can alleviate water scarcity for most of the US
  - Problem: it will take up to trillions of dollars and decades to solve water problems using current purification methods
  - At this point, new methods are not available in an emergency
- Water availability and quality is an increasing problem
- Planet Earth has 332.5 million square miles of water
  - 99.23% is unusable to us without some type of treatment
  - 1.1 billion people lack clean water
  - In coming decades, 700 million people in China and another 700 million in India, and up to 30 million in the US could be without adequate water; severe economic and security effects will result from this water scarcity
  - 35-37 children die every 10 minutes in the developing world from the lack of water. In Bangladesh and East India, 30 million people are currently exposed to poisonous levels of arsenic in the water
- Economics, security, and demand drive effects and population growth. Climate change accelerates them

photo courtesy of **Jeff Vanuga, USDA Natural Resources Conservation Services**

14 *THE ECONOMICS OF ENERGY IN AGRICULTURE*

Neil Conklin *(Former Director, Economics Division, US Department of Agriculture)*

- In 1850, 90% of energy was produced by biomass
- Agriculture will represent most of the renewable energy sources in years to come, based on the US Department of Agriculture (USDA) 10-year projections for renewable energy sources
  - In 2006, ethanol was 14% of domestic corn use
  - In 2007, ethanol was 20% of domestic corn use
  - The US accounts for 60% of global corn exports
  - USDA projected that in 10 years the yearly output in the US will be between 10-12 billion gallons of corn-based ethanol (this converts to 238-285 million barrels)[5]
  - USDA's 10-year projection finds that ethanol will compose 7% of our gasoline and 21% of our corn use
- Some of the downsides to producing corn-based ethanol include:
  - Agriculture and energy policies are increasingly intertwined
    - Strain on both leads to corn-based ethanol as a less efficient, or beneficial, renewable
    - The opportunity cost for use of corn for ethanol has had an impact on global food prices
    - Water and land resource inputs are greater than the output produced — the level of energy and resources it takes to create corn-ethanol are greater than the output
    - Others point to sugar cane and cellulosic ethanol as more efficient
    - There is a large demand correlated with the strain on resources (related to the input)

15 *ENERGY ON MILITARY INSTALLATIONS: A PANEL DISCUSSION*

Get Moy *(Office of Secretary of Defense — OSD);* **Danny Gore** *(US Coast Guard);* **Don Juhasz** *(US Army);* **Brian Lally** *(US Air Force);* **Bill Tayler** *(US Navy);* **Bill Browning** *(Defense Science Board)*

US Coast Guard, Energy Program

- Coast Guard spends approximately $280 million on energy consumption, about 80% of the Department of Homeland Security's (DHS) annual energy consumption
- $50 million is spent annually on energy projects
- Facility energy conservation from 1985 saved 25 million (35% of shore energy budget)
- Renewables
  - Landfill Gas Project at Curtis Bay Shipyard
  - Wind turbine feasibility studies
  - Solar projects
- Coast Guard's goal: to avoid infrastructural costs and implement alternative energies (landfill gas, wind turbine, and solar)

[5] Since Conklin spoke, corn-ethanol has become increasingly refuted as a viable alternative due to its massive use of land resources

US Army, Energy Program

- ❖ DOD's goal: generate 25% of its energy through renewable sources by 2025
- ❖ US Army is dependent on foreign oil:
  - 38% rise in Non-Tactical Vehicle fuel use
  - 35% of DOD utilities
  - 21% of federal government
  - 11% of installations budget
- ❖ Army energy accomplishments:
  - 26.4% reduction in energy consumption from 1985 to 2006
  - $576 million Energy Savings Performance Contracts through private investment in 109 contracts from 1996-2006
  - $38.4 million on the Energy Conservation Investment Program (22 projects) 2005-2006
  - Introduced 23,500+ alternate fuel vehicles — 48% of the Non-Tactical Vehicle fleet
  - Conducted energy awareness and conservation assessment visits at 11 Army installations to find low-cost/no-cost energy savings opportunities
  - Conducted an Army Energy Forum for installation energy managers
- ❖ The Army was a $24.0 billion utilities infrastructure and spends $1.2 billion annual utilities
- ❖ Five goals of energy strategy: 25-year plan
  - Eliminate energy waste in existing facilities
  - Increase energy efficiency in new construction/renovations
  - Reduce dependence on fossil fuels
  - Conserve water resources
  - Improve energy security

US Air Force Energy Programs[6]

- ❖ Buildings — Air Force average energy use per square 1000 feet is 135,000 BTUs per year (about the average of buildings across US)
- ❖ Partnering with Department of Energy to study buildings
- ❖ Overall installation energy strategy is rooted in three areas:
  - Reduce demand; demand-side conservation
    - Supply-side assurance
    - Creating a culture in the Air Force where every airman considers energy in everything
  - The Four pillars of strategy and priority:
    - Focus on current infrastructure
    - Improve future infrastructure
    - Expand use of renewable energy and efficiency technologies
    - Manage costs
  - Air Force 10-15 year strategy:
    - Achieve LEED certifications in all future projects
    - Increase renewable use to 25% over the next 20 years

[6] More up-to-date Air Force energy statistics are in Mark Lewis's December 10, 2007 presentation

US Navy, Energy Program

- Between 1985 and 2005, the Navy reduced consumption by 30% (a $400 million avoided cost)
- Navy now has a goal of reducing consumption by 3% per year
- Navy budgets between $170-200 million per year on energy projects
- Renewables:
  - Geothermal — currently working on the third and fourth production projects
    The China Lake project alone is enough to supply 180,000 homes with electricity
  - Solar and photovoltaic
  - Ocean power — Navy has a natural ability to leverage the benefits of ocean power due to its global onshore base presence
- Training:
  - Energy education at regional locations four times/year
  - Energy as a part of prospective commanding officers' courses
    - Incentive year-round campaigns
    - Fun runs
    - Giving away "freebees"
- Awareness:
  - Secretary of Navy award ceremony began in the 1970s following the oil embargo
  - Energy literacy initiatives
- Efficiency:
  - Resource efficiency manager on every base to identify and implement energy programs. Efficiency manager must produce two times his/her salary in savings

16 *NO LONGER TILTING AT WINDMILLS*

Robert Thresher *(director of the National Wind Technology, National Renewable Energy Laboratory);* **Robert Gramlich** *(American Wind Energy Association)*

- At current growth rates, 100,000 megawatts of wind power could be installed by 2020
  - Generate 20% of the nation's electricity
  - Support 500,000 jobs
  - Reduce greenhouse gas emissions equal to taking 140 million vehicles off the road
  - Save 4 trillion gallons of water
- This would require 300 gigawatt wind power installations
- Increasing wind power to this level from 11.6 gigawatts in 2006 would require significant changes in transmission, manufacturing, and markets
- In July 2007, wind produced less than 1% of the nation's power, but it grew 45% that year, and is increasing steadily
- In 2008, US passed Germany to become world leader in wind generation, generating more than $18 billion in revenue and doubling installed wind power generating capacity since 2006

- ❖21,000 megawatts of capacity are expected to generate 60 billion kilowatt hours of electricity in 2009, enough to serve 5.5 million American homes
- ❖This capacity is estimated to displace the burning of 30.4 million short tons of coal (enough to fill a coal train that would stretch 2,000 miles, from Washington DC to central Utah)
- ❖The American Wind Energy Association calculates 60 billion kilowatt hours of wind power will displace 91million barrels of oil or 560 billion cubic feet of natural gas — about 9% of the natural gas used for US electricity generation
- ❖US wind site capacity is 78% coastal in 28 states. Currently 2/3 of wind transmission is in Texas; 43 states have some wind capacity
- ❖Going off shore is 30-50% more expensive
- ❖Initiatives to Improve Wind Turbine Performance:
  - Avoid problems before installation
    - Improve reliability of turbines and components
    - Full-scale testing prior to commercial introduction
    - Development of appropriate design criteria, specifications, and standard
    - Validation of design tools
  - Monitor performance
    - Monitor and evaluate turbine and wind-plant performance
    - Performance tracking by independent parties
    - Early identification of problems
  - Rapid deployment of problem resolution
    - Develop and communicate problem solutions
    - Focused activities with stakeholders to address critical issues
    - The Gearbox Reliability Collaborative (GRC) initiated by the National Renewable Energy Labortory (NREL) has established significant frameworks

17 *EFFICIENCY AND THE ELECTRIC GRID*

John Wellinghoff *(commissioner, Federal Energy Regulatory Commission);*
Mike Warwick *(Pacific Northwest Laboratory)*

- ❖Smart Grid: how to take advantage of the new competitive technological advances in the delivery of electric services to improve productivity and lower bottom line energy costs
- ❖The consumer sees the utility as power on demand:
  - Unlimited amount
  - Constant frequency
  - Minimal interference or harmonics
- ❖Demand for energy services — including from the grid — are increasing globally
- ❖Nearly 50% of US grid electricity is from coal-based plants; problems will increase in coming years if basic operating principles are not changed to a diversified and distributed grid from the current centralized model
- ❖Smart Grid: two-way power and interconnection data flow and self-generation with transformation to unit voltage and frequency

- Consumer ability to integrate home-based renewables (e.g. wind, solar, etc.) straight into the unit

❖ Consumer ability to use loads as grid resources (like plug-in hybrid electric vehicles (PHEVs)) for improved grid efficiency and lowering consumer costs

❖ Recommendation: Generate a price-based demand management network wherein the consumer plays a greater role in diversifying the grid and increasing efficiency while lowering consumer energy service costs

18 *THE ABOVE-GROUND CHALLENGE: NATIONAL PETROLEUM COUNCIL REPORT*[7]

Frank Verrastro and Sarah Ladislaw *(Center for Strategic and International Studies)*[8]

❖ The report was commissioned by former Secretary of Energy Samuel Bodman in an attempt to discern the future of oil and other fossil fuels

❖ Challenging but manageable view of the future of oil to 2030
- Other reports project further out — as far as 2050 and draw more alarming conclusions

❖ Study listed seven findings about the current and emerging state of energy (See *Table 1)*:

Type	2010	2030
Oil	39%	33%
Coal	24%	27%
Hydro/renewables	8%	9%
Natural gas	23%	26%
Nuclear	6%	5%

Table 1. Expected Global Energy Demand, National Petroleum Council's Report

- Energy demand will grow 50% through 2030, and remain predominantly fossil fuel-based, i.e., coal, oil, and gas
- Study survey suggests that the global energy resource base (molecules in the ground) is enormous, but that "above ground" risks are substantial, posing problems for production, conversion, and delivery.[9] [This is in stark contrast to the views of Matt Simmons, Congressman Roscoe Bartlett and others that resource based "peak oil" is an emerging clear and present reality]

[7] "Facing the Hard Truths about Energy" National Petroleum Council, 2007. www.npchardtruthsreport.org

[8] Verrastro and Ladislaw were commissioned by the National Petroleum Council to write the report

[9] "Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle," US Environmental Protection Agency, 2005.www.epa.gov/oms/climate/420f05004.htm

- To meet projected increases in global energy demand, all sources of energy (conventional, non-conventional, nuclear, renewables, etc.) will be needed, but all have challenges — and new energy forms often require new infrastructure
- Massive infrastructural investments are required to enable diversification — this takes time for each technology
- Because of scale and lead times, US energy independence any time soon is unrealistic. Independence should not be confused with enhancing energy security — and there are things we can and should be doing now to do just that (see National Petroleum Council recommendations)
- The bulk of future energy demand growth is forecast to come from developing and emerging economies rather than the Organization of Economic Cooperation and Development — this is part of the changing energy landscape

❖ The National Petroleum Council's authors identify a set of balanced recommendations to enhance security and create sustainable futures. These include:

- Significant improvements in energy efficiency across the board — transport, residential, commercial, and industrial sectors
- Expand and diversify supply — conventional, non-conventional, renewables, etc.
- Strengthen US and global security and better manage geopolitics
- Develop the capabilities to meet the challenges — both infrastructure and human skills/capabilities and increased research and technology development and deployment
- Price carbon

19 *A DRIVING FORCE: ENERGY AT THE DEPARTMENT OF TRANSPORTATION*

Robert A. DeHaan *(Deputy Assistant Secretary of Transportation)*

❖ Vehicle congestion in the US is a crisis and the level of US consumption exacerbates it

❖ Transportation accounts for 11-12% of current Gross Domestic Product (GDP)

- Aviation sector is about $900 billion every year
- Trade component of our economy is about 25 to 28% of GDP

❖ The Department of Transportation is seeking solutions that will reduce truck idling (see *Table 2*)

- "Cold ironing" — ability to plug in power at the port instead of running the engines on the vessel to supply the port power
- It is not a matter of hitting zero in terms of carbon emissions
  - Alleviate vehicle idling

Vehicle type	Annual emissions
Passenger cars	4.78 metric tons CO_2 (1.30 metric tons CE)
Light trucks	6.00 metric tons CO_2 (1.64 metric tons CE)
All passenger vehicles	5.23 metric tons CO_2 (1.43 metric tons CE)

Table 2: Vehicle Emissions (in US annually)[9] Carbon Emitted (CE)

20 *DOD ENERGY RESEARCH AND DEVELOPMENT PANEL*

Rick Carlin *(Director of the Division of Mechanic and Energy Conversion, Office of Naval Research);* **Tom Hartranft** *(Army Energy Branch Chief, Engineer Research and Development Center, Construction Engineering Research Laboratory);* **Mark Lewis** *(US Air Force Chief Scientist to Chief of Staff and Secretary of Air Force);* **Al Shaffer** *(Director of Plans and Policy, Office of Secretary of Defense/Director, Defense Research and Engineering)*

- Power delivery, distribution, energy storage, and facility energy conservation technology implementations:
  - Focus: installations and deployed bases
  - Main concerns are energy security, affordability, and sustainability
  - Deployed bases: assessing burdened cost of fuel for electrical generators to power Forward Operating Base (FOB) temporary facilities to include Heating, Ventilation, and Air Conditioning (HVAC) and equipment plug loads
    - Developed guidance for sustainable contingency operations
  - Installations in the continental US:
    - Working systems integration of power delivery and building thermal and electric loads; microgrid power architecture to wheel onsite distributed energy resources power anywhere at any time on installation. Facilitates 'islanding': installation from regional utility power grid during regional power outages lasting hours or months
    - Developed energy conservation specifications for new military construction requests for proposals that ensure 30% better than the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) energy efficiency standard. Corps of Engineers implemented 2008
    - Now developing similar specs for incorporating energy technologies in existing buildings during major retrofits
- Research and development programs in Office of Naval Research (ONR):
  - Energy is 90% of the entire ONR Research and Development budget
  - Research areas include:
    - Advanced naval power systems
    - Air platform power
    - Power electronic
    - Personal power (e.g. light, compact 250-1000 watt generators)
    - Bio-sensors, materials, processes
    - Manufacturing science
    - Functional materials
  - Many ONR technologies are not available on the commercial market
  - Angles by which ONR looks at energy innovation:
    - Fuel management — (e.g., Marines manage the cost of delivery to the battlefield). Units getting smaller, more agile, and networked make it complicated but potentially cost effective
    - Strategic standpoint — ONR looked at synthetic fuels (e.g., biodiesel; Fischer-Tropsch process). Methane hydrate was found to emit more

greenhouse gas than carbon dioxide. Fuel cell combustion engine in which methane hydrates could be turned into hydrogen

❖ Air Force energy crisis:
- Two central assumptions:
  - Aerospace systems are ultimately energy systems in that they convert chemical energy in liquid fuel to useful kinetic energy for flight
  - Every great advancement in the aerospace sciences has begun with advancement in propulsion and power
- Systems of flight are systems of energy
  - Improvement begins and ends with energy
  - Air Force is the single biggest user of fuel in the US
  - Entire US government accounts for nearly 2% of the nation's energy consumption — Air Force alone consumes 50% of that
- Air Force budget for fuel is $6 billion per year. Every time the cost of a barrel of oil goes up by $10, the fuel budget goes up by $600 million
- Focusing on facilities is the easiest way to make changes because it is mainly a matter of electricity efficiency
- The other 80+% of Air Force consumption is in flight (See *Figure 3*)
- It is difficult, time-consuming, and costly to make a more efficient airplane
  - Propulsion and power (i.e., energy) is the fundamental input in changing the system
- Address basic range equation — to improve the distance a plane can travel on a tank of gas, one must do at least one of the following:
  - Produce a more efficient engine
  - Redesign it for a more aerodynamic shape
  - Improve the structural weight fraction of the plane
  - Simply fly less often
- Possible improvements in lift-to-drag ratios could greatly improve efficiency
- Increase use of unmanned vehicles

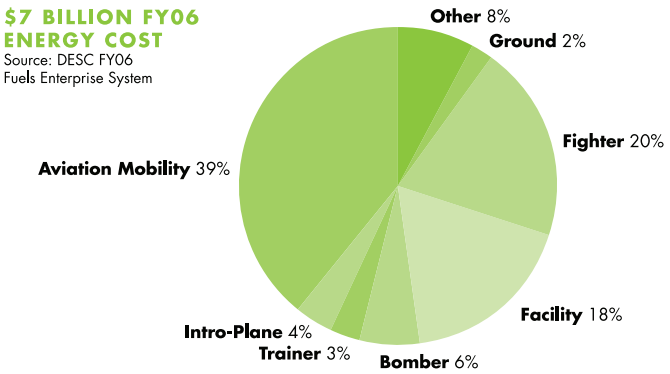


Figure 3: "Energy Challenges and Opportunities for the USAF," Source: Dr. Mark J. Lewis. (Power Point briefing), US Air Force, December 10, 2007

21 *BIOFUELS: AT WHAT COST?*

Glenn Prickett *(Conservation International and the Center for Environment Leadership in Business)*

- Central points of a sustainable energy community:
  - Weaning the nation off oil
  - Diversifying sources of energy while understanding we will probably not be free of oil anytime soon
  - Strategy should focus on conservation, efficiency, and diversity of renewables
  - Increase focus on conservation of natural resources, ecosystems, and species
  - As we release CO^2 into atmosphere — which contributes to climate change — consider the amount of CO^2 sequestration necessary to offset it
    - Biofuels aid in lowering the amount of greenhouse gases released into the atmosphere
- Transportation biofuel feasibility and its connection with the environment and economic development:
  - Agricultural biofuels have a greater input to output ratio than crude oil
  - Prospects of biofuels; intriguing opportunities for developing countries (e.g., Philippines and Cambodia)
    - Brazil grew tremendously from massive sugar-cane capacity (sugar-cane ethanol)
- Use of land for energy is an opportunity cost:
  - For food-based consumption needs
  - Much Brazilian rainforest has been cut down in order to make land available for sugar cane crops
- Sustainability balance between food, land, and energy demands; not fully realized
- Agriculture is a major contributor to environmental degradation:
  - 20% of the greenhouse gas emissions come from burning and clearing of forests, largely as a result of agricultural expansion
  - 14% come from agriculture and livestock operations globally
  - Production of biofuel increases expansion of agriculture and further potential to degrade ecosystems. Hence, there is a need to "think carefully and plan strategically about the expansion of agriculture"
- Recommendations:
  - Pull together land and resource suitability information in order to provide governments with a set of viable strategic options in agricultural expansion
  - Move beyond sugarcane, palm oil, and corn ethanols

22 *ENERGY CONVERSATION WITH THE PRESIDENT'S SCIENCE ADVISOR*

John Marburger III (*Former Science Advisor to the President, Director of the Office of Science and Technology Policy)*

- The greatest challenge of climate science is the estimation of impacts. The Intergovernmental Panel on Climate Change (IPCC) forms the basis of US climate change policy
- Anthropogenic climate change is not the only source of risk to vulnerable populations. Population growth, industrialization, global mobility, inadequate public health arrangements, and ineffective governments all multiply the negative impacts of climate change. We need to find a balance between mitigation and adaptation
  - Despite the difficulty of forecasting regional impacts, some strategies are obvious. Populations that are already stressed by flooding, drought, and desertification are clearly vulnerable. Investments in better water management, zoning regulations, and agricultural practices will have an immediate impact on the quality of life for these populations, and they are also an essential part of any climate response strategy
  - Needs of the present versus those of the future
  - Obligations to humanity coupled with those of energy security
- US energy data:
  - Of the 27 billion tons per year of CO^2 that the US emits, 40% is coal, 40% is oil, and most of the rest is natural gas
  - The US makes up about 20% of global energy consumption and about 20% of global carbon emissions
  - The approach to mitigating climate change seems obvious. In the short run, we should produce fewer greenhouse gases and increase absorption of those already in the atmosphere. In the long run, we need to eliminate releases of fossil carbon altogether, or limit releases to an amount much smaller than current values
  - This must begin immediately because Earth's heat balance is already tilted, and some effects of massive CO^2 production are already evident
- The challenge to shift away from fossil fuels is sobering
  - Today, very few low-carbon technologies exist that can be expanded to the necessary scale
  - Only one, nuclear fission, is sufficiently mature and sufficiently scalable to be a serious contender with low-cost coal plants
  - It would take an additional 136 nuclear power plants — or 270,000 wind turbines — to achieve a 4% reduction in global carbon emissions

- Economic development is paved with fossil fuels
  - For any given economy, CO^2 production is roughly proportional to Gross Domestic Product (GDP). The good news, however, is that the coefficient proportionality is sensitive to technology
  - In other words, introducing modern energy technologies in the rapidly developing parts of the world can slow the growth of fossil CO^2 relative to the historical development path
  - Thus, the objective of a CO^2 mitigation strategy should be to reduce the carbon intensity of the world's economy toward zero
- Why shouldn't the goal be simply to reduce the absolute carbon emission toward zero? Why bring in the notion of "intensity"?
  - Because the cause of our climate anxiety — the root cause — is the overwhelming desire of people everywhere to improve their lot
- Let us be clear that if we are serious about combating anthropogenic climate change, fossil fuel carbon emissions must be reduced in all major economies
  - It is not enough for only the "old rich" economies of Europe, America, and Japan to eliminate their emissions. All populous countries must eventually adopt low- or no-carbon energy technologies
- In the long run, the research and development areas on the supply side that promise the greatest payoff for energy security and mitigating climate change are carbon capture and storage from coal-fired power plants, and improvements in the reduction of waste and proliferation risk associated with nuclear facilities
- On the demand side, how much energy we use depends on cultural behavior It is difficult to measure how people will respond to policies and education
  - We need more information on barriers to acceptance of socially beneficial technologies
- In view of these considerations, what constitutes a rational path forward?
- Recommendations:
  - Address climate change — every major economy in the world needs to make some kind of commitment to long-term emissions reduction
  - For both climate change and energy security — technology development must focus on scalable sources (nuclear power, and coal with carbon capture and sequestration) while maintaining progress in other areas such as renewable power and efficient end uses
  - We need better data and agreement on data definitions and measurements that permit comparisons of energy use not only among countries, but also in different economic sectors within the same country
  - We need some sort of international financial framework that takes into account private as well as public investments in energy infrastructure
  - To prepare for the inevitable effects of climate change, much more attention needs to be given to adaptation
  - All countries need an increased focus on research in low-carbon energy technology

23 *PLAN B 3.0*

Lester Brown *(Earth Policy Institute)*

- The interdependence of energy and climate change and their effects on civilization:
- Arctic ice is melting at an unprecedented rate
  - In 2008, a piece twice the size of Great Britain broke off. Later a three mile-wide glacier in Greenland separated from land
  - Melting is currently occurring at a rate of 2 meters per hour
  - This dramatic rate is causing seismic events in the process
  - Sea levels could rise as high as 16 feet from Antarctica and 23 feet from Greenland, a total of 39 feet worldwide
- China; ice melting rates are unprecedented
  - Concerns of water depletion
    - Some Chinese glaciers are melting at a rate of 7% per year (Illumisoc glacier is melting at a rate of 2 meters per hour)
    - The Ganges and Yellow rivers are threatened with becoming seasonal rivers
    - Could threaten migratory habits, inland development, population, and sustainability
    - Could greatly affect Chinese and Indian security in years to come
  - Threat to food security; food is a world market
    - If Chinese drive up food prices this will add tension to the fact that China owns over $1 trillion in US Treasury bonds
- All tied to CO^2 emissions
  - What percentage is necessary to cut in order to avoid further exacerbating the effects?
  - Some maintain 80% cut by 2050 is adequate
  - Brown's plan — 80% cut by 2020 is necessary
- Two threats compound the global perspective on the security of civilization:
  - Peak oil — indicated by increasingly higher prices and decreasing degrees of newly discovered reserves. When peak oil does occur, no state will get more oil without another getting less
  - Rise in food prices associated with the shift to ethanol (either cane or corn) and landmass taken up by it
    - Through grain, the food and energy markets are fusing
    - Both have strains on each other
    - Tied to the value of oil
    - Threats will lead to an increase in the number of failed states. How many failed states are necessary before civilization completely unravels?
- Findings and recommendations:
  - Stabilize the climate by pursuing new energy infrastructures and renewable energy solutions like wind, solar, geothermal, hydropower
  - Address population; in turn this would address world poverty problem
  - Restore Earth's systems (i.e. soils), including de-carbonizing the atmosphere
  - Increase the number of trees on Earth in order to sequester carbon. A newly planted tree in the tropics can remove 50 kilograms of CO^2 from the atmosphere each year during its 20 to 50 year growth period

- Lower income tax and increase CO^2 tax (this would not increase the net amount of taxes, but rather shift incentives in order to effect national behavior)
- Efficiency and conservation
- Retrofitting existing buildings with better insulation and efficient appliances can cut energy use by 20 to 50%
- Energy efficient compact fluorescent lamps (CFLs) can cut energy use by 75% and last up to ten times as long. The energy saved by replacing one conventional incandescent 100-watt bulb with CFL over its lifetime is enough to drive a Toyota Prius hybrid from New York City to San Francisco
- Appliances: Japan's Top Runner Program sets efficiency standards that have helped Japan boost the efficiency of refrigerators by 55%, air conditioners by 68%, and computers by 99%
  - Standby mode adds up to 10% electricity consumption. Industry standards like South Korea's 1-watt standby limit push manufacturers toward energy efficient design. Unplugging electronics or using smart power strips also helps

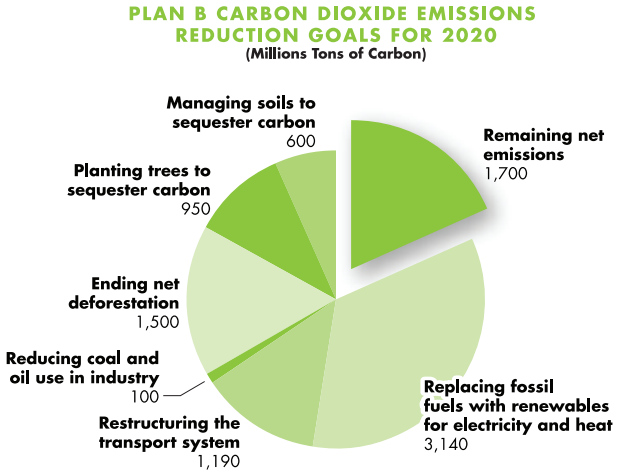


Figure 4: Baseline Emissions (2006) = 9,180 Million Tons of Carbon
(Source: Environmental Performance Index)

24 *GIGAWATT RENEWABLES*

John Mizroch *(Principle Deputy Assistant Secretary, Energy Efficiency and Renewable Energy, at Department of Energy)*

- ❖ Energy Efficiency and Renewable Energy (EERE) at the Department of Energy (DOE) is aimed at addressing energy security and climate change
- ❖ Current status of energy demand:
  - US spends more on oil imports than on national defense
    - $1.5 billion per day (about $550 billion per year)
    - Buildings in the US use two thirds of electricity (one third of all energy)

- Why are we in this situation?
  - A combination of incredible worldwide population growth and urbanization
    - Currently, 800 cities over 1 million; 41 mega-cities reaching 10 million
    - This is also reflected in the trends in transportation: 79 million vehicles in the US in 1950; 600 million vehicles in 1990; and 900 million vehicles today
  - Trend in China is particularly alarming:
    - 1990, China did not allow personal vehicles
    - China bought 7 million personal vehicles in 2006 alone and will soon have a total of 200 million
    - India is following suit
    - China spent $600 million this year on alternative fuel and vehicle technology
- EERE looks at goals in three areas:
  - Power generation
  - Fuels
  - Vehicles and energy efficiency
- Specific programs at EREE include:
  - Zero houses and buildings (design and technology aimed at generating as much energy as they consume, if not more)[10]
    - This could improve efficiency in 50% of newly constructed buildings
    - Retrofit homes and buildings are not considered
  - 536 assessments of energy-intensive industrial facilities have identified more than $863 million in energy cost savings
  - Vehicle technologies (batteries):
    - Both lithium ion and nickel medal hydride batteries could drastically reduce fossil fuel consumption. Neither is yet on a mass production scale but Ford, California Edison, and General Motors are testing
  - Cellulosic concentrates on waste and other forms (feed stock, switch grass, etc.)
  - Wind energy industry is mature and ready for development. We need transmission and grid integration
  - US is spending more on bio/cellulose than any other country. Projected capacity to eventually produce 60 billion gallons (1.4 billion barrels)

25 *THE INTERCONNECTIONS OF ENERGY AND WATER*

Robert Wilkinson *(Water Expert, University of California, Santa Barbara)*

- Global climate change predictions are getting tighter — activity and effects on much larger systems can be predicted with some degree of accuracy today
- Associated human health factors related with climate change range dramatically
- Patterns are essential to consider
  - Dry areas could get drier and wet areas could get wetter
  - Climate fluctuation could occur as onset occurs
- Concern with energy inputs to water systems
- Energy intensity of water supply sources in Southern California for instance, is sobering:
  - 38% of freshwater is used for thermoelectric
  - Only 3% is for consumption

[10] He did not identify them as carbon neutral

- Vulnerabilities in water infrastructure:
  - Following 9/11, security at water facilities across the US was reexamined and tightened for fear of deliberate contamination by terrorists
  - Fort Tejon, California, water facility experienced, in 1857, what has been called the largest earthquake in recorded history to hit the state. If water facilities experienced these today, with the infrastructure — largely built several decades ago for a different era's demographic needs — this could have devastating effects on local populations and sustainability
- Vulnerability warrants a reexamination of transfer and distribution
  - Water efficiency would yield the greatest impact in mitigation of the potential effects from depletion
  - New ways of recapturing water, recycling, and integrated management (e.g., use of grey water)

26 *ENERGY AND CLIMATE: IT'S ALL ABOUT THE SYSTEMS*

Jed Shilling, Hans Herren, Andrea Bassi *(The Millennium Institute);*
Peter Schultz, *(US Climate Change Science Program)*

- Threshold 21 (T21) is a dynamic simulation tool designed to support comprehensive, integrated, long-term national development planning
- T21 supports comparative analysis of different policy options, and helps users identify the set of policies that tend to lead towards a desired goal
- T21 was developed from more than 20 years of extensive research and application carried out in consultation with the World Bank, UN agencies, developing country governments, and non-governmental organizations
- T21 is transparent, collaborative, interconnected, robust, and customizable, and it includes many critical features that support an inclusive, comprehensive, and integrated development planning process
- The most important application of T21 is contribution to the national planning process
- Once a country identifies its vision, and key goals are determined, T21 generates scenarios describing the future consequences of the proposed strategies
- T21 is an especially useful tool for preparing Poverty Reduction Strategies that emphasize the Millennium Development Goals (MDG), and for monitoring progress towards the MDGs or other national goals
- T21 supports stakeholder consultations, prepares strategy documents that address sectoral or industrial interests, prepares data and analysis for loan negotiations, and monitors and evaluates national plans
- System dynamics methodology
  - Based on wide range of existing sector models and analysis
  - Built to reflect observed real world relations in country of application
  - Analyzes cross-sector links and feedback loops
- Composed of three main pillars:

- Economic — based on Social Accounting Matrix (SAM), key market balances, and production
- Social — based on dynamics in population, health, HIV/AIDS, education
- Environmental — based on area specific issues and information

❖ Adapted to data, issues, objectives, actual relations in country

❖ Highlights inter-sectoral feedbacks to show overall implications

❖ Calibrated against history to provide reality checks

❖ Generates long-term scenarios

❖ Transparent and easy to use

❖ Systemic issues now recognized:
- Rising energy prices and limited resources
- Energy security and dependence on imports
- Costs of shift to renewables
- Rising food prices
- Increased pollution and greenhouse gases
- Economic slow-down
- Challenges of global warming

❖ Sector presentations in previous sessions:
- Nuclear, solar, biofuels, wind
- Agriculture and water
- Conservation activities
- Security issues, etc.

❖ Need for systemic approach to understand the dynamic relations better:
- Systems approach helps design, disseminate, and promote coherent and effective polices over the long term
- T21 is a comprehensive tool to help do this
- Descriptive vs. prescriptive structures:
  - Descriptive: aiming at understanding systems
  - Prescriptive: aiming at applying assumptions
  - The results are not necessarily directly related to assumptions
- Causality vs. correlation
  - Represents feedback loops, nonlinearity, delays
  - Simulates against history
- Policy evaluation vs. policy optimization
  - Supports a collaborative approach and model development

❖ T21 energy structure
- Core structure of the energy sectors:
  - Endogenous energy demand, supply, technology, prices, pollution, trade, and investment
  - Six types of energy (supply — oil, coal, gas, nuclear, renewable, and electricity).
  - Four final energy uses (residential, commercial, industrial, transportation)
  - End-use energy demand (decided on country basis analysis)

27 *BARRIERS AND CHALLENGES TO BUILDING THE SMART GRID*

John Wellinghoff *(Commissioner, Federal Energy Regulation Commission)*

❖ Now:
- There are very few sensors on the grid today
- Basically blind, prone to failures and blackouts
- Checking equipment happens manually

20TH CENTURY GRID		21ST CENTURY GRID
Electromechanical	➡	Digital
One-way communications (if any)	➡	Two-way communications
Built for centralized generation	➡	Accommodates distributed generation
Radial topology	➡	Network topology
Few sensors	➡	Monitors and sensors throughout
"Blind"	➡	Self-monitoring
Manual restoration	➡	Semi-automated restoration; eventually, self-healing
Prone to failures and blackouts	➡	Adaptive protection and islanding
Check equipment manually	➡	Monitor equipment remotely
Emergency decisions by committee and phone	➡	Decision support systems, predictive reliability
Limited control over power flows	➡	Pervasive control systems
Limited price information	➡	Full price information
Few customer choices	➡	Many customer choices

Figure 5: Comparison of 20th century grid to tomorrow's grid infrastructure

- Emergency decisions rarely made by committee or by phone
- Limited control over power flows
- Limited price information
- Few customer choices
- Scattered data from the transmission system gives data every 3 seconds

❖ In the future:
- Monitors and sensors will be throughout the grid in an intelligent system
- Adaptive, protective, and islanding
- Self-monitoring and/or monitored remotely
- Decision support systems will be predictive and reliable
- Pervasive control over power flows
- Full-price information to consumers to use to modify and control their loads

❖ Many customer choices

❖ Intelligent load control — smart grid monitoring built into appliances to make them more grid responsive

- ❖ System rapidly detects and analyzes, reports, and restores outages
- ❖ Advanced visualization tools enable better operating and response options:
  - One of the intelligent asset management tools is a visualization system looking at some standard metrics like balance of resource and demand, and also frequency response and real-time alarming
- ❖ Phase monitoring unit will give data every 30th of a second
- ❖ Plug-in hybrid electric vehicles (PHEV) can be used as grid support devices when not in use, resulting in payments from the utility company for using the PHEV to support the grid for regulation services
  - University of Delaware in conjunction with PJM and Federal Energy Regulatory Commission (FERC) testing
- ❖ Intelligent load control utilizes a chip in water heaters, dishwashers, washing machines and refrigerators to sense frequency response on the grid and based upon that correlation, appliances can be set on or off automatically
  - Consumers have full override control
  - IBM test pilot consumers saved $30-$40/month on their electric bill
  - The transmission and distribution system looks at all the grid assets collectively to improve the effectiveness of the asset management systems
- ❖ FERC authority enacted through:
  - Federal Power Act
  - 2005 Energy Policy Act under Section 1223
  - Section 1221 (Section 215 of the Federal Power Act)
  - 2007 Energy Act

28 *GERMANY'S TRANSFORMATION INTO A WORLD LEADER FOR RENEWABLE ENERGY*

Mario-Ingo Soos *(Counselor on Environment and Energy at the German Embassy);*
Dr. Jeffrey Michel *(Electrical Engineer — International Power Meter Industry)*

Three major challenges to how Germany produces and consumes energy:

- ❖ Climate change
- ❖ Energy security
- ❖ Sustainable economic growth to pay for the changes to the energy infrastructure
  - 65% of the global greenhouse gas emissions are produced from energy consumption
  - The European Union declared it will reduce its emissions 30% by 2020
    - For Germany, compared to 1990 levels, the greenhouse gas emissions have been reduced by 20%

Key to the Renewable Energy Sources Act? — it's the law

- ❖ Guarantees the feed-in of electricity from renewable energy at a fair and fixed fee
- ❖ Gives priority to renewable energy
- ❖ Fees are established for each kilowatt hour of electricity, additional costs apportioned to all consumers

- ❖ Renewable energies help Germany save about $7 billion per year in avoided import costs
- ❖ Number of jobs estimated to increase to 500,000 by 2020 and 800,000 by 2030
- ❖ Germany has approximately half a million solar installations
- ❖ Germany excavates the equivalent of the Suez Canal every 25 days to generate electricity from domestic lignite to produce a quarter of its electricity
  - ◆ 180 million tons of lignite are used every year
    - ▪ Surface mining is the cheapest way to get something out of the earth
    - ▪ The emissions trading price is on the rise
    - ▪ If Germany can't meet Kyoto targets, the price of lignite will go up, which means it effectively triples the cost of lignite. This is why mining companies are going bankrupt
- ❖ In the year 2010, Germany will have 23% nuclear power CO^2-free
  - ◆ 17% renewable energies, and coal, lignite, and gas generate the rest
  - ◆ In 2020, Germany will have almost no nuclear power
    - ▪ Renewables will increase to 30%
    - ▪ 67% will be taken over by fossil fuels
- ❖ The problem with carbon capture and storage (CCS) is that you need more energy to capture the CO^2, compress it through a pipeline, and pump it underground
- ❖ A CCS power plant must double the water of regular plants — prohibitive for the western part of the US because they don't have enough cooling water
- ❖ Electronic power metering is capable of reporting changes on a real-time basis
  - ◆ Starting in 2010, all new and fully renovated homes in Germany have to be equipped with an intelligent power meters
  - ◆ Organizations say that even by 2015, only 25% of all households will be equipped in Germany
  - ◆ In the US, 80-90% will be metered

29 *THE BETTER PLACE MODEL FOR BREAKING OIL DEPENDENCE*

Michael Granoff *(Head of Oil Independence Policies, Better Place)*

Better Place is an international company based in Israel that takes a novel approach to transportation without oil. Since its launch in 2007, Better Place has received over $200 million in private financing, altered the tax law in Israel to support its business model, and aligned with Renault and Nissan to manufacture its electric vehicles. Better Place is currently working with California and Hawaii on groundbreaking sustainable transportation infrastructure

- ❖ The US uses oil about three times faster than it is produced — importing 65%
- ❖ The world's oil fields that are in production today are declining at somewhere between 5-9% annually
- ❖ Project Better Place has three goals: sustainable transportation, global energy independence, and freedom from oil

- A lithium ion battery that could fit into a car safely and power that car, according to the performance needs that are at least as good as what we're accustomed to, has a range of 100-120 miles
- 95% of the time we get in our car we don't go more than a hundred miles
- With the Better Place system, for a long trip, you would stop at a battery exchange station and mechanically have your battery exchanged
- All of the batteries would be part of the infrastructure

❖ Better Place buys the electricity, and sells miles to the consumer who subscribes to the service:
- according to driving habits and best value

❖ Currently, energy inefficient cars are being built:
- We must convince the companies that build them to build the right cars

❖ Israel, Denmark, Australia, and Japan are pursuing the Better Place model
- It would cost ~$500 per car for the infrastructure, which provides range extension to the electric vehicles
- Operating cost would be ~8 cents a mile, a fraction of the cost to drive current vehicles while maintaining the gas station infrastructure
- Rebates could be applied to new electric vehicle purchases in order to reduce up-front cost to consumers
- Integration of global positioning services with other services, including energy management services is interactive between the control center and the vehicles
- The battery would be charged and ready at the estimated arrival time to the battery exchange station
- Every parking spot would have a plug — the ability for someone who's driving an all-electric car to come to work and know that by the end of the day, the car will be fully charged
- The utility companies are moving into smart-grid technology that will determine which cars need to be charging most, while the rest of the vehicles can charge whenever the grid is at its lowest level of demand
- Renault-Nissan are taking existing car manufacturing models and modifying them for mass production and deployment
- In vehicle-to-grid technology, intermittency of renewable energy would be utilized as the grid demands and would flatten that demand curve on the electricity grid

30 *HOW IBM WENT FROM BLUE TO GREEN AND STAYED OUT OF THE RED*

Todd Ramsey *(IBM Managing Director)*

❖ Rising concern over energy and climate change is one of the significant forces reshaping governments and societies around the world
- Changing demographics: Longer life spans, lower birth rates, aging population, dynamic work force
- Accelerating globalization: Developed countries erosion of industrial jobs, growing migratory work force
- Rising environmental concerns: Climate change, flood, droughts, pollution,

long cycle times for correction
- Evolving societal relationships: Integrated delivery of secure services anywhere at any time, blending cultures, immigration, regional conflicts
- Expanding impact of technology: Infrastructure, collaboration, interoperability, pace of technology

❖ Global energy demand is fast outstripping global supply in an era of rapid worldwide development (particularly China, India)

❖ Global oil production is peaking/declining, while prices have dramatically risen/fluctuated between two and seven times in the last 10 years. Oil and petroleum products fuel the global economy

❖ Global warming and climate change, largely due to energy waste (greenhouse gases), threaten the planet's ability to sustain life

❖ Soaring food and energy costs pushed consumer prices up at the second fastest rate in a quarter-century in the US

❖ The Intergovernmental Panel on Climate Change (IPCC) calls for a 50-85% reduction in CO^2 emissions by 2050 to mitigate the risks of climate change

❖ The G-8 countries (US, UK, France, Germany, Italy, Japan, Canada, Russia) agreed to a 50% reduction in greenhouse gas emissions by 2050

❖ By 2025, freshwater resources for over half the world's countries across the globe will either undergo stress or realize outright shortages

❖ Green data centers are energy efficient and environmentally responsible

❖ Proven results have been achieved in IBM data centers
- 45% reduction in power and cooling
- 20% increase in server/storage utilization

❖ Both private and public sectors report significant results using energy efficient technologies and services
- Average achievable energy savings greater than 40%
- Data center energy efficiency assessment shows average payback less than two years
- Average utilization rates increased two to four times
- $1 energy savings drives another $6 to $8 in operational savings on average
- Efficiency projects ranged from 2,000 sq ft to 180,000+ sq ft

❖ Today's major drivers include:
- Rising cost of fuel
- Increasing traffic congestion
- Mandated reductions in greenhouse gas emissions
- Heightened corporate environmental responsibility
- Tightening talent pools/employee preferences and expectations

❖ Factors favoring transitioning government employees to work at home are:
- Employees are spending in excess of $9,789/year commuting five days/week, dispersing eight tons of pollutants into the environment and using 233 hours for travel to and from work
- Telecommuting three days/week could save $5,878 and disperse 4.5 tons less pollutants

- Mobility solutions are enabled today by substantial improvements in technologies and infrastructure
  - Improving and cheaper bandwidth to home
  - More reliable and secure virtual private networks
  - Increased availability of private or shared mobile work centers
  - Improved collaboration and communications software
- Workforce mobility provides the following opportunities for our clients:
  - Attracts best talent and aids in the retention of current employees
  - Grows the organization without increasing real estate investment
  - Encourages individuals to provide, update, and capture knowledge, information, and data
  - Ensures continuity of operations during disasters and emergencies
  - Increases productivity and enhances employee engagement and work-life balance
  - Leverages innovative technologies and enables cognitive diversity
  - Promotes environmental consciousness and encourages employees to develop sustainable practices
- Smarter supply chain:
  - Increased visibility and control
  - Integration and synchronization with supplier and partner network
  - Carbon trade-off modeling
  - Advanced business activity monitoring
  - Advanced business process simulation
  - Built on a robust Service-Oriented Architecture (SOA) foundation
- Smarter water management is an imperative in a world faced with scarce water resources
- Peoples' actions impact the environment — leadership will enable necessary changes in behavior
- US average behavior breakdown
  - Home energy 36.2%
  - Driving and flying 44.3%
  - Food and diet 15.1%
  - Recycling and waste 4.4%
- Workforce globalization allows us to compose worldwide teams

31 *ENERGY POLICY IN LIGHT OF A NEW PRESIDENT AND CONGRESS*

David Hawkins *(Director, Natural Resources Defense Council Climate Center);* **Joel Beauvais** *(Majority Counsel to the House Select Committee on Energy Independence and Global Warming)*

- President Obama has proposed creating 459,000 jobs by investing in clean energy, doubling the production of alternative energy in the next 3 years, modernizing 75+% of the federal buildings, and improving the energy efficiency of 2 million homes

- Climate change is a critical issue because we cannot have a strong economy without a stable climate
- An energy policy that ignores factors that impact climate change will fail
- On economic security, the US needs to capture markets for new technology
- The US needs to focus on delivering a manufacturing sector that will produce high-efficiency vehicles and smarter appliances that the world will want to buy
- Technologies to create smart power distribution systems will be increasing demand globally
- 31 states have either substantial coal production or use 70+% coal in their electric power mix, which makes it challenging for Congress to pass legislation that would increase the cost of coal production and use through carbon capture and disposal (CCD)
  - CCD is a technique for separating out CO^2 from power plant streams, compressing it, and then injecting it into geologic formations where it is intended to remain indefinitely
- CO^2 has a long half-life in the atmosphere, so simply slowing the rate of exploitation is not going to solve the climate problem
  - About one half of the CO^2 that was put into the atmosphere through World War I remains in the atmosphere today
- Currently, there are 1300 gigawatts of coal capacity globally
- Coal production costs would increase by ~40% when carbon capture technologies are implemented at a coal plant
- ~60% of the cost of electricity on an electricity bill is the production cost, with the remainder constituting transmission and distribution expenses and energy losses
- Based on input-output models, funding spent on green jobs would create four times the number of jobs as those dollars spent in the oil sector, and the pay range was substantially better by comparison to alternatives, with an estimated 1.3% impact on unemployment
- The US produces ~250,000 barrels a day of oil from CO^2 injection projects; ten times that amount could be produced if enough CO^2 were available
- A well-designed climate policy would create the incentives needed to deploy CCD technology

photo courtesy of **Randy Montoya, Sandia National Laboratories**

1 ***ENERGY, SECURITY AND THE LONG WAR OF THE 21ST CENTURY***, March 27, 2006, **R. James Woolsey**

James Woolsey joined VantagePoint in March 2008. Mr. Woolsey was a Partner with Booz Allen Hamilton in McLean, Virginia, specializing in energy and security issues. Prior to that he was a partner with Shea and Gardner in Washington, DC for 22 years on four different occasions and served five times in the federal government for a total of 12 years, holding presidential appointments in two Democratic and two Republican administrations. He served as Director of Central Intelligence (1993-95), Ambassador and Chief Negotiator for the Conventional Armed Forces in Europe (CFE) Treaty in Vienna (1989-91), Delegate at Large (on a part-time basis) to the Strategic Arms Reductions Talks (START) and the Defense and Space Talks in Geneva (1983-86), Under Secretary of the Navy (1977-79), and General Counsel to the US Senate committee on Armed Services (1970-73).

2 ***AVERTING A LIQUID FUEL CRISIS FROM PEAK OIL***, April 24, 2006, **Robert Hirsch** and **Congressman Roscoe Bartlett**

Dr. Robert L. Hirsch is a Senior Energy Program Advisor at SAIC. His past positions include Senior Energy Analyst at RAND; Executive Advisor to the President of Advanced Power Technologies, Inc.; Vice President, Washington Office, Electric Power Research Institute; Vice President and Manager of Research, ARCO Oil and Gas Company; CEO of ARCO Power Technologies, a company that he founded; Manager, Baytown Research and Development Division and General Manager, Exploratory Research, Exxon Research and Engineering Company; Assistant Administrator for Solar, Geothermal, and Advanced Energy Systems (Presidential Appointment), and Director, Division of Magnetic Fusion Energy Research, US Energy Research and Development Administration.

Honorable Roscoe Bartlett is a US Congressman from Maryland who was re-elected in 2008 to serve his ninth term representing the Sixth District of Maryland in the US House of Representatives. He is one of four scientists in the Congress. He is a 16-year member of the House Armed Services Committee. For the past 6 years, Dr. Bartlett has been Chairman or Ranking Member of its Subcommittee on Seapower and Expeditionary Forces. Dr. Bartlett is also a member of both the House Science and Technology Committee and Small Business Committee. Dr. Bartlett was awarded 20 patents for life-support equipment he invented for military pilots and astronauts. He has authored more than 100 studies published in peer-reviewed scientific journals.

3 ***THE HYDROGEN ECONOMY***, May 22, 2006, **Jeremy Rifkin**

Jeremy Rifkin is President of the Foundation on Economic Trends and the author of 17 bestselling books on the impact of scientific and technological changes on the economy, the workforce, society, and the environment. Mr. Rifkin is currently advising the government of France and has served as an adviser to Chancellor Angela Merkel of Germany, Prime Minister José Sócrates of Portugal, and Prime Minister Janez Jansa of Slovenia, during their respective European Council Presidencies, on issues related to the economy, climate change, and energy security. He currently advises the European Commission, the European Parliament, and several

EU heads of state, including Prime Minister José Luis Rodríguez Zapatero of Spain and Chancellor Angela Merkel of Germany. Mr. Rifkin is the founder and president of The Foundation on Economic Trends (www.foet.org) in Bethesda, MD.

4 *TWILIGHT IN THE DESERT*, June 20, 2006, **Matthew R. Simmons**

Matthew Simmons is Chairman of Simmons and Company International, a specialized energy investment banking firm. Mr. Simmons' book, *Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy*, has been listed on the *Wall Street Journal's* best-seller list. He has also published numerous energy papers for industrial journals and is a frequent speaker at government forums, energy symposiums, and in board rooms of many leading energy companies around the world.

5 *BIOFUELS AND BIOMASS*, July 17, 2006, **Dr. Michael Pacheco** and **Suzanne Hunt**

Dr. Michael Pacheco is the vice president for Program Development at Midwest Research Institute (MRI) and the vice president for Deployment and Industry Partnerships at the National Renewable Energy Laboratory (NREL). He recently led MRI's launch of a new 74-acre test site for validation testing of solar energy system components. At NREL, he is currently responsible for creating a new centralized organization of NREL's deployment programs and activities, including: the Federal Energy Management Program (FEMP), Integrated Deployment projects, Weatherization and Intergovernmental, Clean Cities, Wind Powering America, Solar America Initiative, the Small Business Program, Industry Partnerships, as well as the State, Local, and Tribal initiatives. Pacheco has 28 years of experience in research, manufacturing, management, and technical strategy development.

Suzanne Hunt is the Founding President of Hunt Green, LLC, which advises on climate change, energy, agriculture, and the environment. Clients include the US Department of Energy, the Inter-American Development Bank, the Natural Resources Defense Council, Wolfensohn & Co., the Global Bioenergy Partnership, and the UN Food and Agriculture Organization. Previously, Ms. Hunt directed the Worldwatch Institute's bioenergy program, where she orchestrated the landmark study, "Biofuels for Transportation: Global Potential and Implications for Energy and Agriculture." Full bio and publications are available online at: www.bioenergywiki.net/index.php/User:Shunt.

6 *NUCLEAR ENERGY: STATUS AND OUTLOOK*, September 18, 2006, **Admiral Frank L. (Skip) Bowman**

Frank L. (Skip) Bowman recently retired as president and CEO of the Nuclear Energy Institute (NEI), which represents more than 300 domestic and international corporations and organizations involved in nuclear energy and related technologies. Prior to joining NEI in 2005, Bowman served for more than 38 years in the US Navy, rising to the rank of admiral. He served as director of the Naval Nuclear Propulsion Program and was concurrently deputy administrator-Naval Reactors in the National Nuclear Security Administration of the US Department of Energy. Bowman also served as the Chief of Naval Personnel. Bowman serves on the BP America Advisory Council, on the National Security Advisory Council of the Center for US Global Engagement, and on the MIT Nuclear Engineering Visiting Committee.

He is a member of the American Nuclear Society, the Council on Foreign Relations, the Management Committee of the Alliance for Energy and Economic Growth, Women in Nuclear, and the World Nuclear Association's Council of Advisors.

7 ***ADVANCES IN SYSTEMS APPLICATION OF SOLAR POWER FOR CRITICAL FUNCTIONS***, October 16, 2006, **Scott Sklar** and **Robert Birkmire**

Scott Sklar is founder and president of The Stella Group, Ltd., The Stella Group, Ltd., is a strategic marketing and policy firm for clean distributed energy users and companies. He has two co-authored books, A *Consumer Guide to Solar Energy, and 'The Forbidden Fuel: Power Alcohol in the Twentieth Century*. His Q&A and commentary contributions appear on the largest clean energy web portal: www.RenewableEnergyWorld.com. Scott Sklar is Chair of the Steering Committee of the Sustainable Energy Coalition and serves on the non-profit Boards of the Business Council for Sustainable Energy and the Renewable Energy Policy Project, and co-chairs the Policy Committee of the Sustainable Buildings Industry Council.

Dr. Robert W. Birkmire is the director of the Institute of Energy Conversion, a United States Department of Energy Center of Excellence for Photovoltaic Research and Education, as well as Professor of Materials Science and Engineering with a secondary appointment as Professor of Physics at the University of Delaware. He has been principal investigator on numerous government and industrial contracts on amorphous and polycrystalline thin film solar cells and crystalline Si solar cells, and is actively involved in developing effective mechanisms to transfer laboratory results to commercial processes with particular emphasis on implementing model-based process control schemes using advanced sensor technologies. Dr. Birkmire is author of over 150 technical publications and is inventor on eight US patents.

8. ***A PARADIGM SHIFT — FROM WASTE TO FUEL***, November 13, 2006, **Brian S. Appel**

Brian Appel is Chairman and CEO of Changing World Technologies, Inc. (CWT). Mr. Appel founded CWT in 1997, and started up the Thermal Conversion Process research and development facility in Philadelphia, PA in 1999. The Thermal Conversion Process uses water, heat, and pressure to convert wastes into renewable diesel, fertilizers, and other usable products. Mr. Appel is a patent holder on the Thermal Conversion Process and has authored several papers on environmental and energy technology. Mr. Appel is on the board of directors of the New Uses Council and serves as a member of the American Council on Renewable Energy and the Energy Future Coalition.

9 ***THE OIL ENDGAME***, December 12, 2006 and March 11, 2008, **G. Amory Lovins**

Amory Lovins, a MacArthur Fellow and consultant physicist, has advised the energy and other industries as well as the US Departments of Energy and Defense for nearly three decades. Having published 29 books and hundreds of papers, his work in about 50 countries has been recognized by the "Alternative Nobel," Onassis, Nissan, Shingo, and Mitchell Prizes, the Happold Medal, nine honorary doctorates, and the Heinz, Lindbergh, Time Hero for the Planet, and World Technology Awards. He advises industries and governments worldwide, and has briefed 18 heads of state.

He is Chairman and Chief Scientist of the Rocky Mountain Institute (www.rmi.org). His 29th book, *Winning the Oil Endgame* (www.oilendgame.com), was published September 20, 2004. He is also a member of the Defense Science Board Energy Task Forces, 1999-2001 and 2006-2008.

10 ***WAL-MART CUTS ENERGY 30% — WHAT CAN WE LEARN FROM THEM?***, January 19, 2007, **Charles Zimmerman**

Charles Zimmerman is currently the vice-president of Prototype and New Format Development for Wal-Mart Stores, Inc. Mr. Zimmerman is also leading the "Sustainable Buildings Network" at Wal-Mart. Prior to his current role, Mr. Zimmerman worked in the International Division for Wal-Mart Stores as Director of Design and Construction. Mr. Zimmerman has worked for Wal-Mart since 1997. Previously, he worked in both the consulting industry as well as for the Texas State Department of Highways. In 2007, Mr. Zimmerman testified before the US Congress on two separate occasions regarding energy efficiency matters.

11 ***THE ECONOMIC IMPACT OF CLIMATE CHANGE — THE STERN REVIEW REPORT***, February 5, 2007; **Justin Mundy**

Justin Mundy is a Special Advisor on Climate Change to the Foreign Secretary at the British Government's Foreign and Commonwealth Office and a Senior Adviser to the British Government's Department for International Development where he specializes on Russia, climate, and energy issues. Mr. Mundy is also a member of the UK Government's Sustainable Energy Policy Advisory Board. During the United Nations Framework Convention on Climate Change sixth and seventh Conference of Parties, Mr. Mundy was appointed adviser to the European Commission on EU-Russia coordination. Previous to joining Deutsche Bank where he worked on carbon trading, he worked at the World Bank where he ran the Bank's forestry and biodiversity programs in Russia and Central Asia. He was the Environment Adviser for the region's oil and gas sector and sat on the Senior Governmental Advisers Committee for the Ministerial Environment for Europe Process.

12 ***REDUCE COSTS, SAVE ENERGY — BUILDING GREEN: LEEDing THE WAY***, March 19, 2007, **Bob Fox** and **Teresa Pohlman**

Bob Fox is one of New York City's most highly respected leaders in the green building movement. An advisor to Mayor Michael Bloomberg's Office of Long-Term Planning and Sustainability, Bob has been honored with many awards, including a Leadership Award from the US Green Building Council, the New York City Council's inaugural "Big Green Apple" Award, and the Urban Visionary Award from the Cooper Union. A founding partner of Fox & Fowle Architects, Bob guided that firm to a position of national leadership in the design of sustainable high-rise buildings, including the influential 4 Times Square/Condé Nast Headquarters. In 2003, Bob Fox joined with Richard Cook to form Cook+Fox Architects, a firm devoted to creating beautiful, environmentally responsible, high-performance buildings. In the summer of 2006, Bob joined Bill Browning and Rick Cook to form Terrapin Bright Green LLC.

Dr. Teresa R. Pohlman was the Environmental Division Chief at Headquarters Air Force, and managed the Air Force's $1 billion environmental program, including

cleanup, compliance, conservation, and pollution prevention, for all bases in the US and overseas, including international bilateral agreements with Russia, Norway, Argentina, and Italy. She also served as an Air Force Regional Program Manager with the Air Force Base Conversion Agency for a $300 million program concerned with base closure and disposal issues, closing five Air Force bases. While working for the Navy, she served at the Naval Facilities Engineering Command Headquarters as the Navy single point of contact for environmental base closure issues. Currently, Dr. Pohlman is the Director, Occupational Safety and Environmental Programs at Headquarters, Department of Homeland Security.

13 ***OUR DEPENDENCE ON WATER — WATER'S DEPENDENCE ON ENERGY***, April 9, 2007, **Mark Shannon**

Mark A. Shannon is the director of the National Science Foundation (NSF) Center of Advanced Materials for Purification of Water with Systems, which is a multiple university and government laboratory center for advancing the science and engineering of materials and systems for revolutionary improvements in water purification for human use. He is also the Director of the Micro-Nano-Mechanical Systems Laboratory at the University of Illinois at Urbana-Champaign. He chaired the Instrument Systems Development Study Session for the National Institutes of Health from 2006 to 2008. He is the James W. Bayne Professor of Mechanical Engineering, and received his B.S. (1989), M.S. (1991), and Ph.D. (1993) degrees in Mechanical Engineering from the University of California at Berkeley. He received the NSF Career Award in 1997 to advance microfabrication technologies, the Xerox Award for Excellence in Research (2004), the Kritzer Scholar (2003-2006), the Willet Faculty Scholar (2004-2007), and received the BP Innovation in Education Award in 2006.

14 ***THE ECONOMICS OF ENERGY IN AGRICULTURE***, May 22, 2007, **Neil Conklin**

Neil C. Conklin was named President of Farm Foundation in January 2008. Dr. Conklin previously served as director of the market and trade economics division of US Department of Agriculture's Economic Research Service (ERS). In that role, he initiated the ERS research program on the economics of bioenergy, and directed development of new modeling frameworks on global trade policy analysis. Before joining ERS in 1999, Dr. Conklin spent 6 years at the Farm Credit Council as vice president and chief economist. He previously worked at the Office of Management and Budget, and has had teaching assignments at Arizona State University, the University of Arizona, and at Colorado State University.

15 ***ENERGY ON MILITARY INSTALLATIONS: A PANEL DISCUSSION***, June 4, 2007, **Get Moy**, **Danny Gore**, **Don Juhasz**, **Brian Lally**, **Bill Tayler** and **Bill Browning**

Dr. Get W. Moy is currently Associate Vice President and senior program director for federal projects for DMJM H&N, a global design, management and technical services firm. Dr. Moy's immediate responsibilities at DMJM H&N include program support for the firm's FEMA disaster recovery program contract. For over two decades, Dr. Moy has served as an engineer for various sectors of the federal government, including the Navy and the DOD. As the Director of Installations

Requirements and Management at the DOD, Moy was responsible for the administration and direction of installations worldwide. His duties included assuring a consistent quality of life for military personnel, the appropriate sizing of domestic and overseas base structures and improving installation management. Dr. Moy is the recipient of the US 2007 Presidential Rank Award for Meritorious Service as well as the National Institute of Building Sciences President's Award. He is a Fellow in the American Society of Civil Engineers, and a member of the United States Naval Institute, the Society of American Military Engineers, and the Tau Beta Pi Engineering Honor Society.

Daniel Gore is the Coast Guard Energy Program Manager. The Coast Guard program represents about 80% of all Department of Homeland Security energy consumption and includes both tactical vehicle fuel and facility utilities. Previously, Danny created the Maritime Energy and Emissions Program for the Maritime Administration, where he served as Chief of the Division of Cost Analysis and Production.

Don Juhasz is a motivational speaker who uses humor and insight to encourage behavioral changes needed to reduce our wasteful actions and processes. He designed his own dream home using the energy savings techniques he has learned as an engineer. He currently serves as the Chief of Energy and Utilities Programs, Headquarters, Department of the Army. He is a Certified Energy Manager with 16 years active involvement performing energy audits and energy reduction project development.

Brian Lally, Executive Director for the Air Force Civil Engineer Support Agency at Tyndall, earned a BS in civil engineering from Lowell Technological Institute in Massachusetts and an MBA from the Florida Institute of Technology. He is a registered professional civil engineer licensed in Virginia. He has 9 years of experience working for the Air Force, the Army Corps of Engineers, and the Navy Public Works Directorates as an engineer, commander, senior program manager, wartime planner, disaster response planner, and contracting officer.

Bill Tayler is Director of Energy and Utilities for both the Assistant Secretary of Navy (Installations and Environment) and for Naval Facilities Engineering Command. He manages the execution of the Secretary of the Navy's Shore Energy and Utility programs. He is the past Chairperson for the Federal Section of the International District Heating and Cooling Association (IDHCA), and a member of the Institute of Electrical and Electronic Engineers and the Association of Energy Engineers. He is winner of the IDHCA's President's Cup, and the recipient of the 2000 Federal Energy and Water Management Award, and the 2003 Presidential Award for Outstanding Leadership in Federal Energy Management.

Early in his career, **Bill Browning** helped build luminary thinker Buckminster Fuller's last experimental structure, based on advanced geometry systems. In 1991, he founded Green Development Services at Rocky Mountain Institute, an entrepreneurial, non-profit "think and do tank" whose work advances energy-efficient and environmentally responsive design. His 300+ consulting projects at Rocky Mountain Institute (RMI) included new towns, resorts, building renovations, and high-profile demonstration projects including Wal-Mart's Eco-mart, the Greening of the White House, and the Sydney 2000 Olympic Village. He also helped bring about energy efficiency

improvements for a number of US Department of Defense facilities, including the Pentagon, the Navy Yard, the Air Force Academy, and the Pacific Air Force Headquarters.

16 ***NO LONGER TILTING AT WINDMILLS***, July 23, 2007, **Robert Thresher** and **Robert Gramlich**

Dr. Robert Thresher has more than 40 years of research, development, engineering, and management experience in wind technology, plant engineering, and aerospace systems. As a professor at Oregon State University, he worked with the Department of Energy to develop early wind technologies. At National Renewable Energy Laboratory he has been a principal researcher developing early wind technology and an architect of the wind program. He helped create of the National Wind Technology Center. He has been a strategist and spokesperson for the initiation of a national research program to develop offshore wind, wave, tidal, and current energy technology.

Rob Gramlich is Policy Director of the American Wind Energy Association, the national trade association of over 1700 entities involved in all aspects of wind energy production. Mr. Gramlich leads the association's strategic initiatives related to transmission infrastructure, electric grid operations, regulatory policy, and policy analysis. He appears frequently at conferences on renewable energy and transmission. He currently serves on the US Department of Energy's Electricity Advisory Committee, and served as the Economic Advisor to FERC Chairman Pat Wood III from 2001 until 2005.

17 ***EFFICIENCY AND THE ELECTRIC GRID***, September 17, 2007, **John Wellinghoff** *and* **Mike Warwick**

Commissioner Jon Wellinghoff is a member of the Federal Energy Regulatory Commission, the agency that oversees wholesale electric transactions, interstate electric transmission, and gas transportation in the US. Wellinghoff is an energy law specialist with more than 30 years experience in the field. Before joining FERC, he was in private practice and focused exclusively on client matters related to renewable energy, energy efficiency, and distributed generation. He represented an array of clients from federal agencies, renewable developers, and large consumers of power to energy efficient product manufacturers and clean energy advocacy organizations. He is a member of the Advisory Committee of the Institute for Electric Efficiency, and he served as an advisor to the Defense Science Board's Energy Policy Task Force. Commissioner Wellinghoff also advises the Energy Foundation and the National Research Defense Council on China-US energy policy matters.

Mike Warwick joined Battelle-Northwest in January 1990 as a Program Manager. His role as a research scientist allows him to focus on strategic issues for utilities, regulators, US Departments of Energy, Defense, and State, Federal Power Marketing Administrations (i.e., the Bonneville Power Administration). Typical subjects include the areas of industry restructuring, energy resource performance and program evaluation, energy markets, and utility management consulting. Mr. Warwick has managed projects in integrated resource planning, DSM program evaluation, and energy resource performance assessment and demonstration. Currently, he leads the laboratory's electricity industry restructuring efforts. Previously, Mr. Warwick led a support contract

with regulators in North Carolina overseeing the implementation of least-cost plans by Duke Power, CP&L, and Virginia Power, and advised them on industry restructuring.

18 ***THE ABOVE-GROUND CHALLENGE: NATIONAL PETROLEUM COUNCIL REPORT***, October 9, 2007, **Frank Verrastro** and **Sarah Ladislaw** *(CSIS)*[11]

Frank Verrastro currently serves as senior fellow and director of the CSIS Energy and National Security Program. His energy-related experience includes over 30 years in energy policy and project management positions in both the US government and the private sector. Government service includes staff positions in the White House (Energy Policy and Planning Staff) and the Departments of Interior and Energy, including serving as deputy assistant secretary for international energy resources. In the private sector, Mr. Verrastro has served as director of refinery policy and crude oil planning for TOSCO (formerly the nation's largest independent refiner) and more recently as senior vice president for Pennzoil. He currently serves on the Advisory Board for the National Renewable Fuels Laboratory in Golden, Colorado.

Sarah Ladislaw is a fellow in the CSIS Energy Program, where she concentrates on issues related to the geopolitical implications of energy production and use, energy security, energy technology, and sustainable development. She has been on the geopolitics portion of the National Petroleum Council study focusing particularly on energy security and climate issues. Sarah worked in the US Department of Energy's Office of Policy and International Affairs from 2003-2006 in the Office of the Americas. She joined the Department of Energy in 2003 as a Presidential Management Fellow, where she covered a wide range of economic, political, and energy issues in North America, the Andean region, and Brazil. While at the Department of Energy she also worked on comparative investment frameworks and trade issues.

19 ***A DRIVING FORCE: ENERGY AT THE DEPARTMENT OF TRANSPORTATION***, November 19, 2007, **Robert A. DeHaan**

Robert DeHaan became Deputy Assistant Secretary of Transportation in September 2006. In this capacity, he assisted the Secretary in fulfilling the Department's twin objectives of ensuring a safe transportation system and reducing congestion across all modes of that system. He also managed the Office of Transportation Policy and its team of transportation analysts. Before that, DeHaan served as Special Counsel to the Deputy US Trade Representative, where he focused particularly on US trade relations with Asia and Africa and worked on the Doha Round of multilateral trade negotiations.

20 ***DOD ENERGY RESEARCH & DEVELOPMENT PANEL***, December 10, 2007, **Richard T. Carlin, Tom Hartranft, Mark Lewis**, and **Al Shaffer**

Dr. Richard T. Carlin became Department Head for the Sea Warfare and Weapons Department at the Office of Naval Research (ONR) in September 2007. As Department Head, Dr. Carlin overseas a broad range of Science and Technology programs for surface ships, submarines, and undersea weapons. Immediately prior to his current position, he was the Director for the Undersea Weapons and Naval Materials Division with responsibilities in undersea weapons and countermeasures, advanced energetics, structural materials (alloys and composites), materials for power

[11] Verrastro and Ladislaw were commissioned by the NPC to write the report.

systems, acoustic transducers, maintenance reduction technologies, and blast mitigation materials. Dr. Carlin has published over 100 technical papers including 57 reviewed papers and one book chapter, and he is also co-inventor on seven US patents.

Dr. Tom Hartranft completed a 20-year Air Force military career focused on tactical weapon systems acquisition in 1995 and returned to Penn State University to pursue a Ph.D. in Mechanical Engineering. He studied thermal sciences under Dr. Gary Settles in the Penn State Gas Dynamics Lab. Dr. Hartranft accepted a 1-year Visiting Assistant Professor of Mechanical Engineering position at Bucknell University for academic year 2000-2001. He accepted his current position in the fall of 2001 as Energy Branch Chief, Construction Engineering Research Laboratory, Engineer Research and Development Center, US Army Corps of Engineers. This office leads Army research, development, and field engineering of stationary power delivery, distribution, energy storage, and demand-side energy conservation technologies.

Dr. Mark J. Lewis is Chief Scientist of the US Air Force, Washington, DC. He serves as chief scientific adviser to the Chief of Staff and Secretary of the Air Force, and provides assessments on a wide range of scientific and technical issues affecting the Air Force mission. Dr. Lewis received his professional education at the Massachusetts Institute of Technology. He is currently on leave from his position as Professor of Aerospace Engineering at the University of Maryland, and as Director of the Space Vehicles Technology Institute, College Park, MD. For the past 19 years, Dr. Lewis has conducted basic and applied research in and taught many aspects of hypersonic aerodynamics, advanced propulsion, and space vehicle design and optimization. Dr. Lewis is the author of more than 220 technical publications and adviser to more than 50 graduate students.

Al Shaffer, Director of Plans and Policy, Office of Secretary of Defense/Director, Defense Research and Engineering, is responsible for formulating, planning, and reviewing the DOD Research, Development, Test, and Evaluation (RDT&E) programs, plans, strategy, and priorities. He is also responsible for the execution of the DOD RDT&E budget. Specifically, this position reviews the maturity of technology as part of the acquisition cycle, as well as develops options to reduce the overall technology development risk to DOD programs. Prior to entering the federal government, Mr. Shaffer served a 24-year US Air Force career with assignments in weather, intelligence, science and technology management, acquisition oversight, and programming.

21 ***BIOFUELS: AT WHAT COST?***, January 14, 2008, **Glenn T. Prickett**

Glenn Prickett is a Senior Vice President with Conservation International, a non-profit organization dedicated to protecting the Earth's biological diversity. Glenn founded and continues to serve as Executive Director of Conservation International's (CI) Center for Environmental Leadership in Business, a division of CI that engages leading global corporations in creating environmental solutions. He is co-author of *Footprints in the Jungle: Natural Resources Industries, Infrastructure, and Biodiversity Conservation* published by Oxford University Press. Prior to joining CI, Glenn served as Chief Environmental Advisor at the US Agency for International Development during the

Clinton Administration and prior to that as a Senior Associate with the Natural Resources Defense Council in Washington, DC. He currently serves on the boards of the Keystone Center, the Northern Virginia Conservation Trust, and the Great Falls Citizens Association.

22 ***ENERGY CONVERSATION WITH THE PRESIDENT'S SCIENCE ADVISOR***, February 11, 2008, **John H. Marburger III**

John Marburger, III, is a former Science Advisor to the President George W. Bush, and he served as Director of Brookhaven National Laboratory from 1998 and as the third President of the State University of New York at Stony Brook (1980-1994). He came to Long Island in 1980 from the University of Southern California, where he had been a Professor of Physics and Electrical Engineering, serving as Physics Department Chairman and Dean of the College of Letters, Arts and Sciences in the 1970's. In the fall of 1994 he returned to the faculty at Stony Brook, teaching and doing research in optical science as a university professor. He developed theory for various laser phenomena and was a co-founder of the University of Southern California's Center for Laser Studies.

23 ***PLAN B 3.0***, April 29, 2008, **Lester Brown**

In 1974, with support of the Rockefeller Brothers Fund, **Lester Brown** founded the Worldwatch Institute, the first research institute devoted to the analysis of global environmental issues. While there he launched the Worldwatch Papers, the annual State of the World reports, World Watch magazine, a second annual entitled *Vital Signs: The Trends That are Shaping Our Future*, and the Environmental Alert book series. Brown has authored or co-authored 50 books. One of the world's most widely published authors, his books have appeared in some 40 languages. His most recent book is *Plan B 3.0: Mobilizing to Save Civilization*. He is the recipient of many prizes and awards, including 23 honorary degrees, a MacArthur Fellowship, the 1987 United Nations' Environment Prize, the 1989 World Wide Fund for Nature Gold Medal, and the 1994 Blue Planet Prize for his "exceptional contributions to solving global environmental problems."

24 ***GIGAWATT RENEWABLES***, May 13, 2008, **John Mizroch**

John Mizroch joined the Department of Energy from his previous position as President and CEO of the World Environment Center (WEC). At WEC, he worked to advance sustainable development by encouraging environmental leadership, helping improve health and safety practices worldwide, and fostering the efficient use of natural resources to protect the global environment. Prior to leading WEC, Mizroch promoted environmental technology transfer and investment in the developing world including Latin America, Asia, and Eastern Europe. Mizroch has been a member of the Trade and Environmental Policy Advisory Committee at the US Trade Representative's Office, and he served on the Cleaner Fossil Fuel Systems Advisory Committee of the World Energy Council.

25 ***THE INTERCONNECTIONS OF ENERGY AND WATER***, June 25, 2008, **Robert C. Wilkinson**

Robert Wilkinson is a Lecturer in the Environmental Studies Program, and the Donald Bren School of Environmental Science and Management, at the University of California, Santa Barbara. Dr. Wilkinson's teaching, research, and consulting focus on water policy, climate change, and environmental policy issues. He also advises various government agencies on these issues. He currently serves on the public advisory committee for California's State Water Plan and he represents the University of California on the Governor's Task Force on Desalination. Dr. Wilkinson is a Senior Fellow with the Rocky Mountain Institute, and he is a founding member of the California Environmental Dialogue and a founding participant in the Aspen Institute's The Environment in the 21st Century.

26. ***ENERGY AND CLIMATE: IT'S ALL ABOUT THE SYSTEMS***, July 24, 2008, **Jed D. Shilling, Hans Herren, Andrea Bassi**, and **Peter Schultz**

Dr. John (Jed) Shilling, Chairman of the Millenium Institute, is retired from the World Bank, where for nearly 30 years he held a number of senior positions. He headed the Bank's efforts in sustainable development, laying the framework for a new environmental strategy. He worked extensively in economic analysis and policy assessments in macroeconomics, environmental sustainability, capital flows and financial markets, and risk assessment, especially in North Africa and Asia. Dr. Shilling consults with nongovernmental organizations, including the World Wildlife Fund and Conversation International, the World Bank, the United Nations, and others on environmental economic issues. He has served on the Boards of the Kenan-Flagler Business School Sustainable Enterprise Program (UNC) and The Mountain Institute. He is currently on the Boards of the Center for Resilience at Ohio State University and the Piedmont Community Foundation.

Hans Herren, an internationally recognized scientist, was appointed President of the Millennium Institute in May 2005. Before that, he was director-general of the International Center for Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya. He also served as director of the Africa Biological Control Center of International Institute of Tropical Agriculture (IITA), in Benin. At ICIPE, Hans developed and implemented programs in the area of human, animal, plant, and environmental health (the 4-H paradigm) as they relate to insect issues. At IITA, he conceived and implemented the highly successful biological control program that saved the African cassava crop, and averted Africa's worst-ever food crisis.

Andrea Bassi, Senior Modeler, joined Millennium Institute (MI) as a research intern in June 2005. He specializes in modeling resource depletion, energy, and environmental issues for MI's Threshold 21 (T21) model. Andrea has been the principal investigator of a number of energy related projects, including T21-USA, Ohio (Environmental Protection Agency Industrial Ecology Project), and Ecuador (validation of the Stern Report). His work on energy issues is currently used by Rep. Roscoe Bartlett (US Congress), Ohio State University, University of North Carolina, Middlebury College, Association for the Study of Peak Oil and Gas (ASPO-USA), and others.

Peter Schultz is the Director of the US Climate Change Science Program Office (CCSPO). His current responsibilities include management of CCSPO's program-wide scientific integration, planning, prioritization, and assessment activities through coordination with the CCSPO Director (a senior manager from National Oceanic and Atmospheric Administration), the CCSPO Principals, and the CCSPO Interagency Working Groups. He joined CCSPO in 2004 as the Associate Director for Science Integration. Prior to that he worked for several years at the National Academies, where he directed or co-directed a dozen scientific studies related to global environmental variability and change.

27 ***BARRIERS AND CHALLENGES TO BUILDING THE SMART GRID***, September 15, 2008, **Commissioner Jon Wellinghoff**

Commissioner Jon Wellinghoff is a member of the Federal Energy Regulatory Commission (FERC), the agency that oversees wholesale electric transactions, interstate electric transmission, and gas transportation in the US. Wellinghoff is an energy law specialist with more than 30 years experience in the field. Before joining FERC, he was in private practice and focused exclusively on client matters related to renewable energy, energy efficiency, and distributed generation. He represented an array of clients from federal agencies, renewable developers, and large consumers of power to energy efficient product manufacturers and clean energy advocacy organizations. He is a member of the Advisory Committee of the Institute for Electric Efficiency, and served as an advisor to the Defense Science Board's Energy Policy Task Force. Commissioner Wellinghoff also advises the Energy Foundation and the National Research Defense Council on China-US energy policy matters.

28 ***GERMANY'S TRANSFORMATION INTO A WORLD LEADER FOR RENEWABLE ENERGY***, October 21, 2008, **Mario-Ingo Soos** and **Dr. Jeffrey Michel**

Mario Ingo-Soos has been serving as Counselor for environmental and energy policy issues at the German Embassy in Washington since July 2006. In that role, he is responsible for analysis and evaluation of US climate and energy policy and communication of German climate and energy policy in the US. Mr. Soos has been with the German Foreign Office since 1989. Prior to coming to Washington he served as head of unit for regional cooperation in Southeast Europe at the German Foreign Office in Berlin. Other assignments include tours as Deputy Chief of Mission at the German Embassy in Nicosia, Cyprus (2000-2003) and assignments at the German Embassies in Zagreb, Croatia, and Bogota, Colombia.

Dr. Jeffrey Michel is an MIT-educated electrical engineer who worked for the Boeing Space Division before moving to Germany in 1970. He began traveling to East Germany and Czechoslovakia in the 1980s to investigate prospects for multinational cooperation in overcoming common environmental problems. As Energy Director of the European Energy and Environment Park in Leipzig from 1992 to 1995, he implemented the first CO^2 model community project in the New German States. He has since served as energy coordinator of Heuersdorf, a historic village that is currently being destroyed by a brown coal (lignite) surface mine operated by two US corporations.

29 ***THE BETTER PLACE MODEL FOR BREAKING OIL DEPENDENCE***, November 11, 2008, **Michael Granoff**

Michael Granoff has been Head of Oil Independence Policies for Better Place since its founding in 2007, helping stakeholders of all types to calibrate policies consistent with the Better Place approach to ending the corrosive effect of oil dependence on the economy, on the environment, and on security. The stakeholders that Mr. Granoff works with include governments on every level, industry, and current and future Better Place partners. Mr. Granoff is founder of Maniv Energy Capital, a New York-based investment group which became the first investor in Better Place. Maniv Energy has several other interests in the alternative energy and clean technology space, and was instrumental in the founding of Israel Cleantech Ventures, the first venture fund in Israel with an exclusive focus on the cleantech space.

30 ***HOW IBM WENT FROM BLUE TO GREEN AND STAYED OUT OF THE RED***, December 9, 2008, **Todd Ramsey**

Todd Ramsey is Managing Director of US Federal, IBM Corporation, where he leads an organization of 5,000 IBM professionals committed to providing information technology and business process solutions to US Federal Government clients. Mr. Ramsey has more than 30 years of service with IBM in both global and US government arenas. Mr. Ramsey joined IBM in 1972 in Endicott, New York, as a hardware systems designer. He later worked as an engineer for both the US Air Force and IBM, specializing in communications systems and NASA space projects. In 1979, he joined the IBM marketing and sales organization and has held a number of management positions, including branch manager in Norfolk, Virginia, and vice president of the IBM Federal Systems Division.

31 ***ENERGY POLICY IN LIGHT OF A NEW PRESIDENT AND CONGRESS***, January 12, 2009, **David Hawkins** and **Joel Beauvais**

David Hawkins is the Director of NRDC's Climate Center. He joined NRDC as an attorney in 1971 and worked on air pollution issues until 1977, when he was appointed assistant administrator for Air, Noise, and Radiation at the Environmental Protection Agency during the Carter administration. David returned to NRDC in 1981 and worked throughout the next decade primarily on reauthorizing the Clean Air Act. David was the Director of NRDC's air and energy program from 1990 to 2001, until he became Director of the newly created Climate Center. David is a recognized expert on advanced coal technologies and carbon capture and storage, and he is working with Congress to design a legislative mechanism to reduce global warming emissions.

Joel Beauvais is Majority Counsel to the House Select Committee on Energy Independence and Global Warming, where his portfolio runs the gamut of domestic and international energy and climate issues. He is the principal drafter of H.R. 6186, the Investing in Climate Action and Protection Act ("iCAP"), a comprehensive economy-wide climate bill sponsored by Select Committee Chairman Edward J. Markey. Prior to joining the Select Committee staff, Mr. Beauvais was an associate with the Washington, DC office of the law firm of Latham & Watkins LLP, where he represented leading industry clients on a broad range of environmental, administrative law, and constitutional matters.

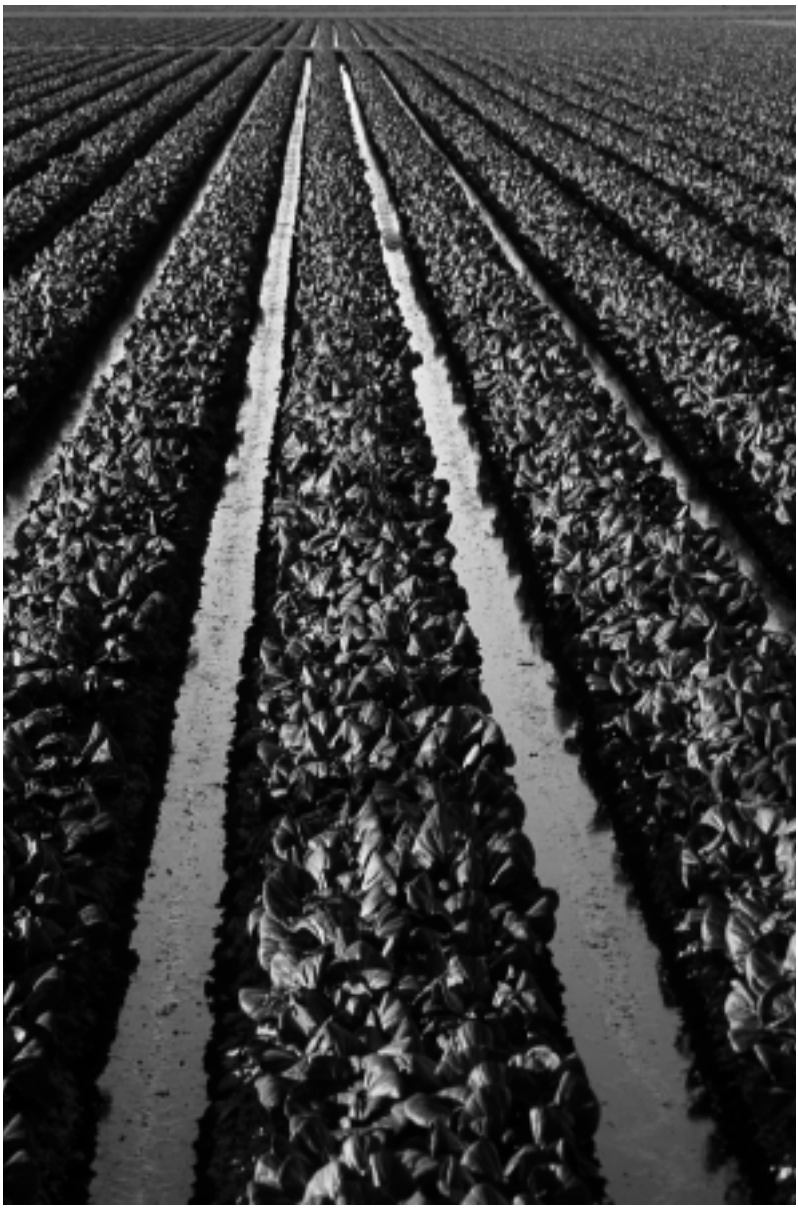


photo courtesy of **Jeff Vanuga, USDA Natural Resources Conservation Services**

THE ENERGY CONVERSATION

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The mission of ***The Energy Conversation*** is to create a collaborative, networked community of Energy Smart advocates to inform, educate and communicate with the American people on how to successfully build a sustainable energy future. By educating the government and the public about sustainability, ***The Energy Conversation*** aims to bring people together to understand the technologies, systems and consequences associated with our actions as well as to foster and showcase the unprecedented collaboration between government, industry and nonprofits.

The Energy Conversation is a systems thinking incubator. And with its three pillars of information sharing, energy literacy, and a speaker series, it is also a social networking system — a community — within which to investigate and navigate the consequences of energy choices, policies, consumerism, and national security.

In partnership with 26 government agencies and departments, ***The Energy Conversation*** stands as a valuable tool for interdepartmental and inter-service working groups to ensure a systems thinking approach is given to energy policy in these critical times.

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